Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

FEBRUARY, 1956

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TECH... DEPT.

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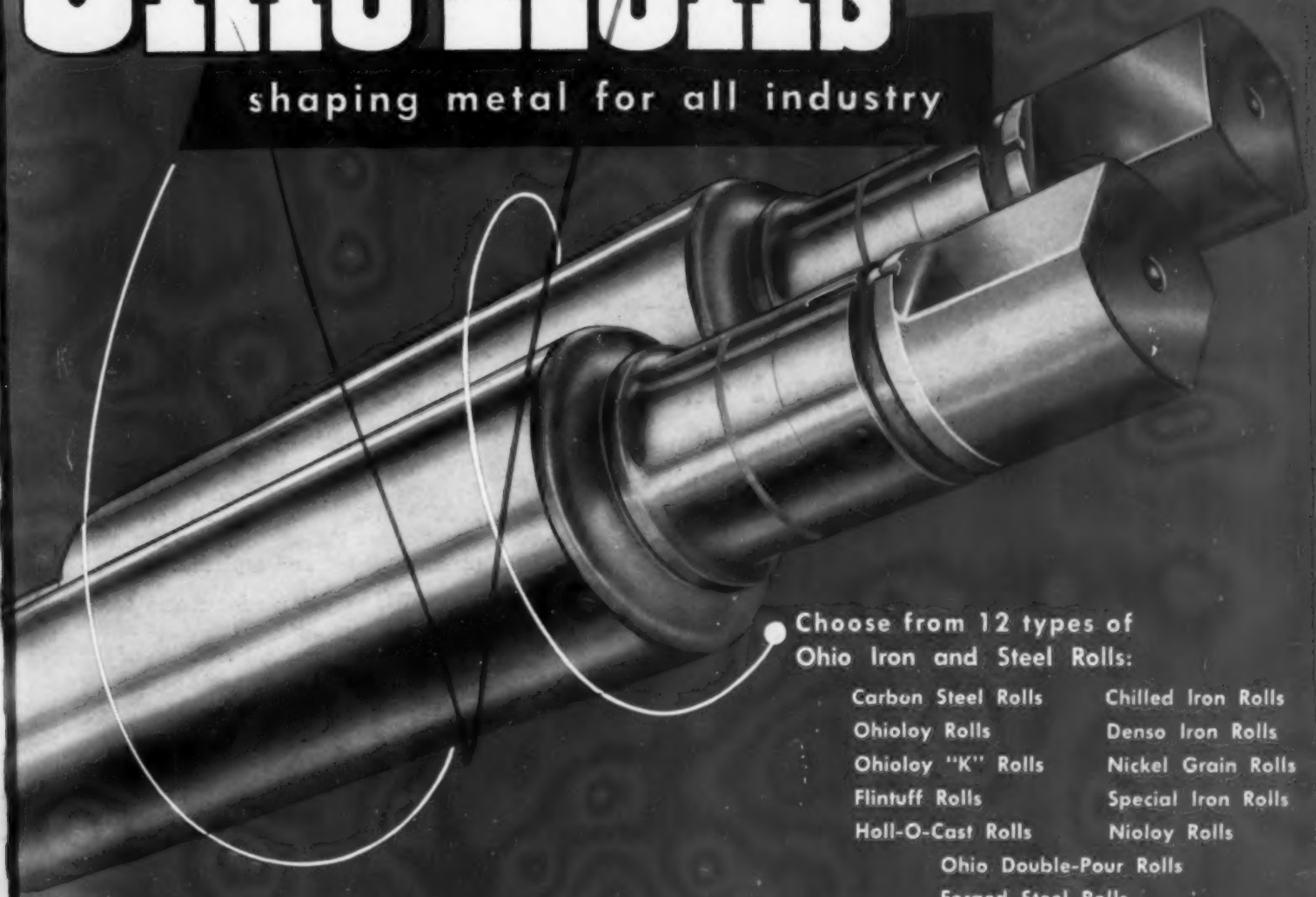
Ohio Rolls

shaping metal for all industry



Choose from 12 types of Ohio Iron and Steel Rolls:

- Carbon Steel Rolls
- Ohioloy Rolls
- Ohioloy "K" Rolls
- Flintuff Rolls
- Holl-O-Cast Rolls
- Chilled Iron Rolls
- Denso Iron Rolls
- Nickel Grain Rolls
- Special Iron Rolls
- Nioloy Rolls
- Ohio Double-Pour Rolls
- Forged Steel Rolls

THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO

Plants at Lima and Springfield, Ohio

This welded magnet can really make sense to you

The *coil* is welded into a capsule, removable and replaceable in the field

The outer pole shoe is welded to the body

And it all adds up to more copper, more lift, more life, more "no-trouble" periods.

Now available to you in a *better* welded design is the Cutler-Hammer Supermagnet . . . the magnet that has been "super" since it started. We say this is better because here welding makes sense. Welding is used to seal the coil into a compact, homogeneous, monolithic mass that is moisture proof and can be removed from the body on the job for repairs without trouble.

Welding is used to unite the cast dynamo steel body and the alloy steel outer pole shoe into a rugged, wear-resistant unit. On the other hand, this unit retains the uniformity of magnetic flux density between the inner and outer pole shoes that means more lifting power, a bigger "bite."

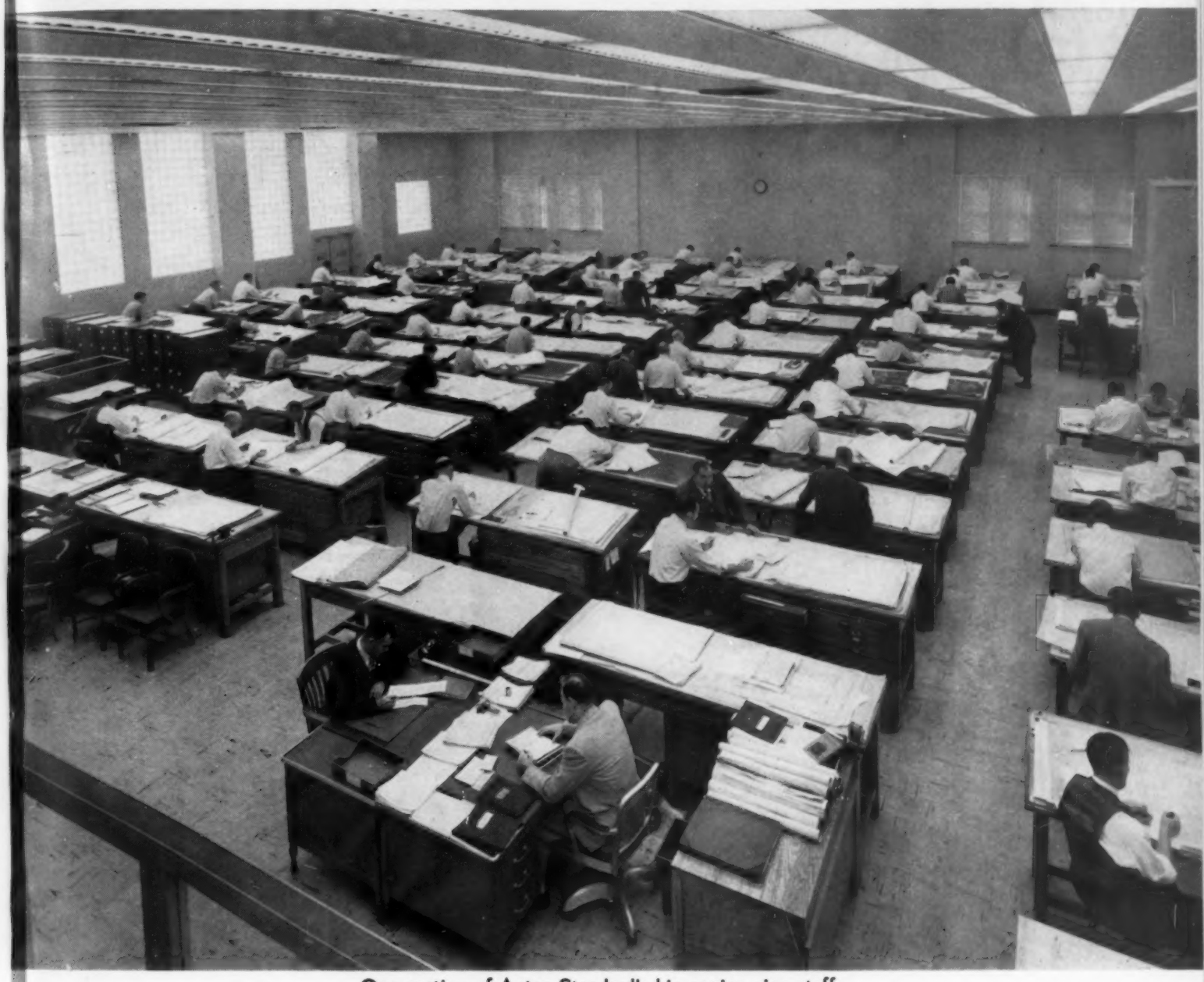
The coil shield has an improved and heavier cross section to better protect the coil. The inner pole shoe—which of all magnet parts gets most wear—is *NOT* welded but held in place by countersunk through bolts, so it can be easily removed and replaced.

You'll find other advantages too—the design of the lugs, the design of the cast steel chain yoke, the design of the terminal box: these are some of the features that make the "Supermagnet" super. Ask for new magnet book THE BIG LIFT. Shows the complete C-H line welded, bolted and special magnets. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin.

CUTLER-HAMMER
SUPERMAGNETS
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., Pittsburgh, Pa. Second class mail privileges authorized at Pittsburgh, Pennsylvania, January 25, 1924.

54 YEARS OF DESIGNING AND BUILDING EQUIPMENT



One section of Aetna-Standard's big engineering staff

men at work for ONE PURPOSE

To develop better equipment and more efficient equipment for production of steel, copper, brass, aluminum, in the form of higher quality pipe and tubing, tin plate, galvanized sheet and strip, cold drawn bars and tubes and many other products.

These engineering **idea men** have one purpose — to transform ideas into equipment as exemplified by the Rotary Hot Saw, the Tube Expander, the 5-Draw Drawbench and many ideas of Continuous Galvanizing, Continuous Electrolytic Tinning and Finishing Equipment.

They do not work alone. Many of the ideas for new equipment originate with you, the customer. The Aetna engineering idea staff refines and develops the idea into equipment. This ability to work with customers is one of Aetna's best assets. . . . That's why Aetna-Standard always has been known as **the idea people.**

AETNA • STANDARD

THE AETNA-STANDARD ENGINEERING COMPANY

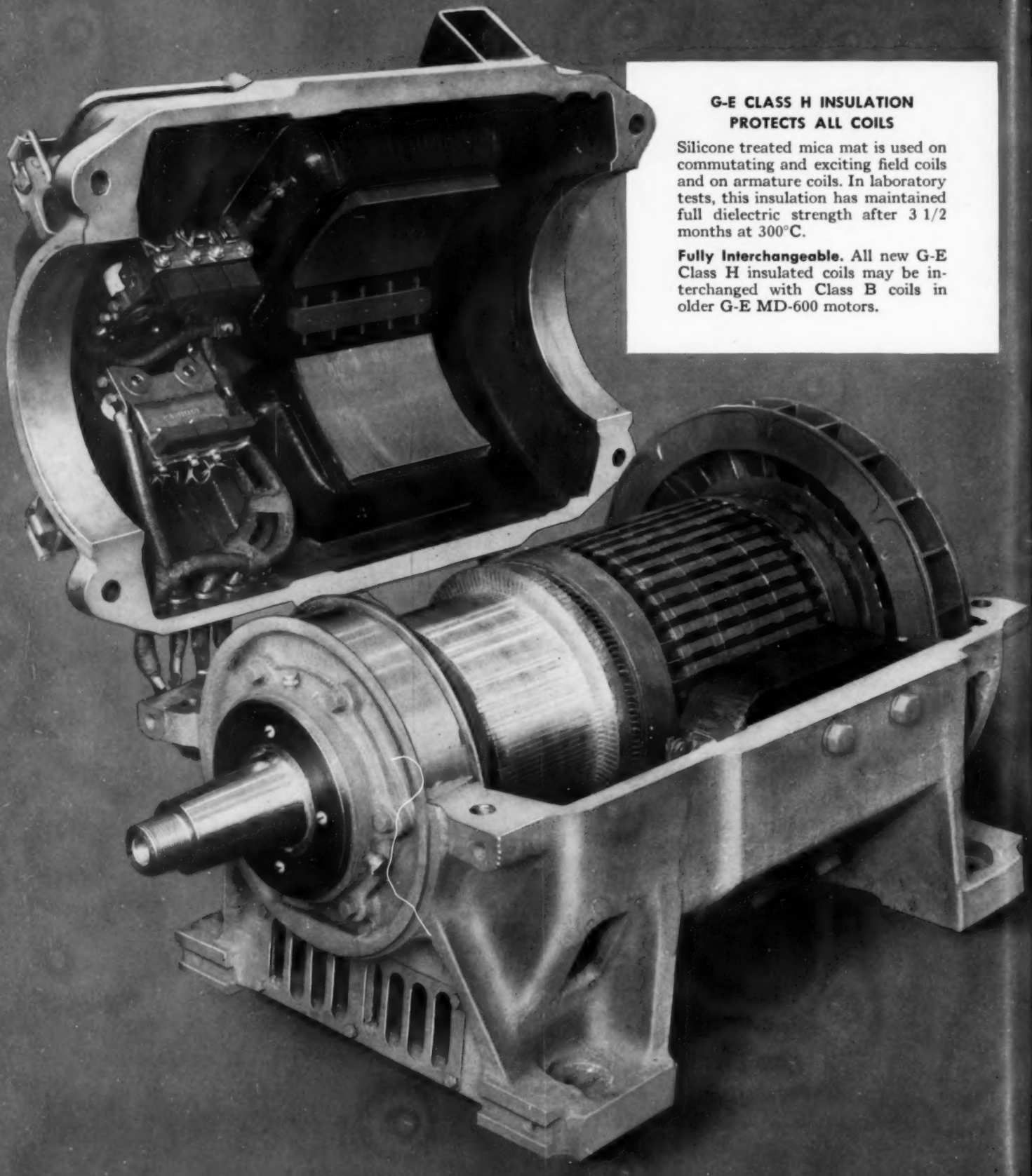
GENERAL OFFICES: PITTSBURGH, PA. PLANTS: ELLWOOD CITY, PA., WARREN, OHIO

CONTINUOUS GALVANIZING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC

PROGRESS IN
DIRECT-CURRENT DRIVES

NOW! Roastouts

NEW G-E MD-600 MOTORS



G-E CLASS H INSULATION PROTECTS ALL COILS

Silicone treated mica mat is used on commutating and exciting field coils and on armature coils. In laboratory tests, this insulation has maintained full dielectric strength after 3 1/2 months at 300°C.

Fully Interchangeable. All new G-E Class H insulated coils may be interchanged with Class B coils in older G-E MD-600 motors.

Virtually Eliminated on . . .

WITH CLASS H INSULATION

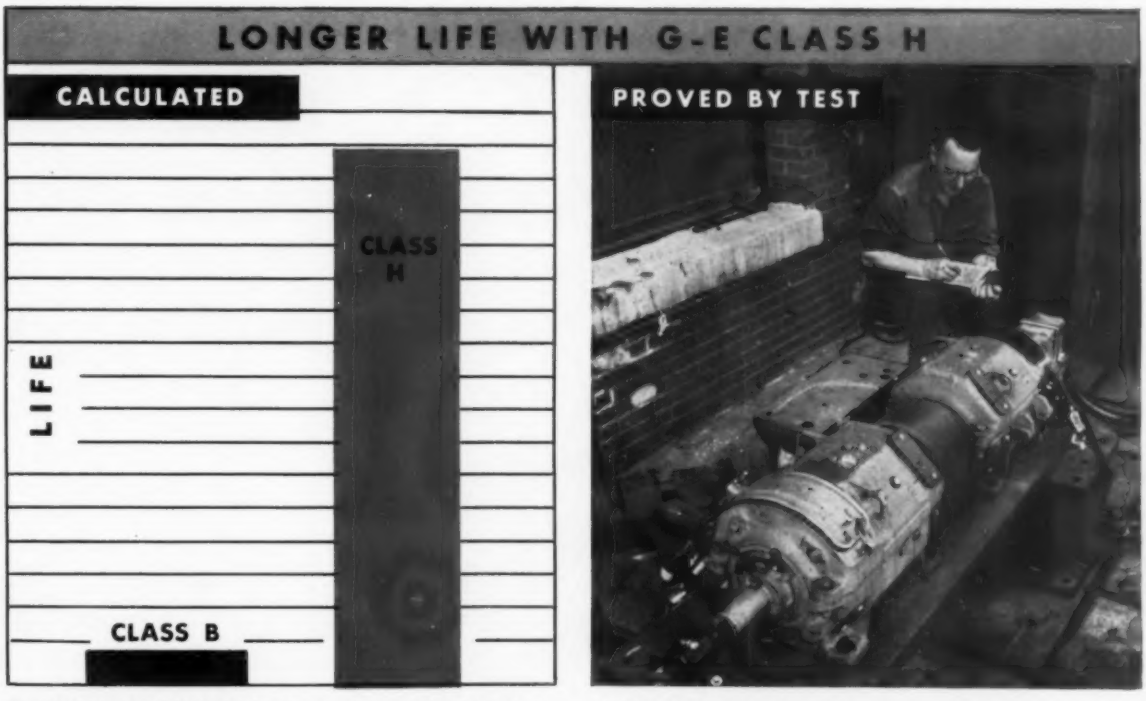
G.E. offers—in all MD-600's—Class H Insulated Coils

WHAT IS CLASS H? General Electric research has developed a combination of inorganic and silicone materials for a new insulation system now used in all MD-600 motors. These Class H materials will withstand temperatures up to 180°C continuously.

BETTER FOR HEAVY DUTY. Auxiliary mill motors often encounter unexpected high ambient temperatures, unforeseen extended duty or emergency conditions. Any one of these can cause "roastouts" from temperatures higher than the insulation capacity. The new G-E Class H insulation will resist up to 50°C more than Class B, resulting in longer motor service.

REWINDS ELIMINATED? On normal duty, insulation failure may be eliminated as the limiting factor in continuous armored motor service. Engineers calculate that each 10°C rise in temperature reduces the life of a given type of insulation by half. *Since G-E Class H will withstand 50°C higher than Class B, its life* **at the same temperature** *should be increased 2^5 or 32 times!*

YOUR G-E SALES REPRESENTATIVE HAS COMPLETE INFORMATION. Contact him at your nearby G-E Apparatus Sales Office, or write Section 812-1, Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.



ENGINEERING STUDIES indicate that under identical operating conditions new G-E Class H insulated coils in MD-600 motors will last up to *32 times* as long as conventional Class B coils. Insulation failure may be eliminated as the limiting factor in continuous auxiliary mill motor service.

ACTUAL TEST with Class H and Class B motors coupled together *proves to date* the new insulation will last more than twice as long as the old. After burning out two Class B insulated motors, the one with Class H coils is still operating under exaggerated load, vibration and atmospheric conditions.

Progress Is Our Most Important Product

GENERAL ELECTRIC

MORE THAN 300 LEADING MANUFACTURERS

are already putting

SKF TYPE "C" BEARINGS

in their products

Here are the trade marks of a few of more than 300 leading manufacturers – companies who want extra bearing performance – who already are using the *improved* SKF Type "C" Spherical Roller Bearing announced less than a year ago.

There are two reasons why

First: They know that for over 40 years, SKF has been *first* with anti-friction developments that *work*.

Second: They obtain, size for size, up to 50% more capacity, 2 to 3½ times increased life with SKF's Type "C" Spherical than they can obtain with any other available design, and at no increase in cost.

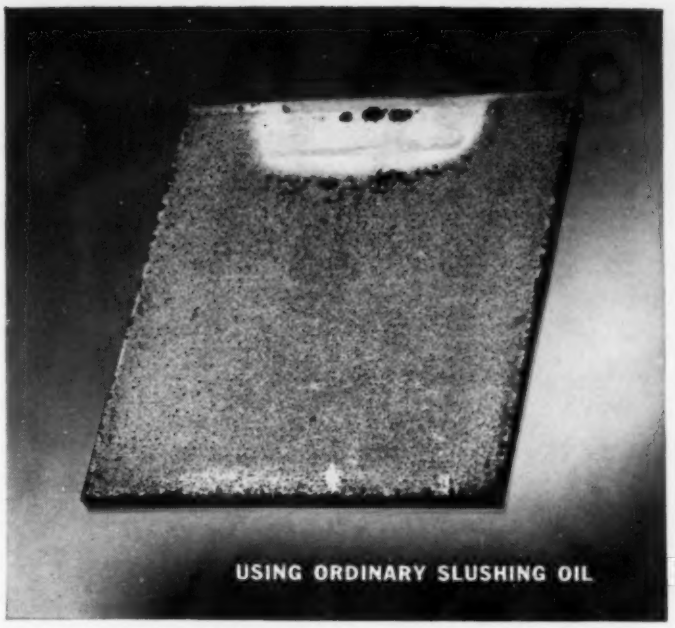
7550

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA
– *manufacturers of* **SKF** *and* HESS-BRIGHT® *bearings.*

©1954 – SKF Industries, Inc.

SKF®

BALL AND ROLLER BEARINGS



Humidity Cabinet Test proves superiority of new coating oil. Using ordinary slushing oil, steel test panel (on left) shows harmful rust after only 100 hours in humidity cabinet with relative humidity of 100% at 120 F. An identical steel test panel (above right), protected by new Sunkote A, shows no rust or stain whatsoever after 200 hours under same rust test conditions of high humidity and temperature.

ANNOUNCING SUNKOTE A

a new, low-cost rust preventive coating for hot and cold rolled strip and sheet steel

SUNKOTE A is easily applied by dip, roller, or spray. Special compounding provides extra protection against rust and stain at lowest cost.

Sunkote A is specifically compounded to protect hot and cold rolled strip and sheet steel against rust and stain for long periods in storage and in transit.

Economical to use, Sunkote A is moderately priced... gives maximum coverage and protection... can be applied by all usual methods... is easily removed by any of the normal cleaning processes.

For complete information about this new product, see your Sun representative...or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. IS-2.

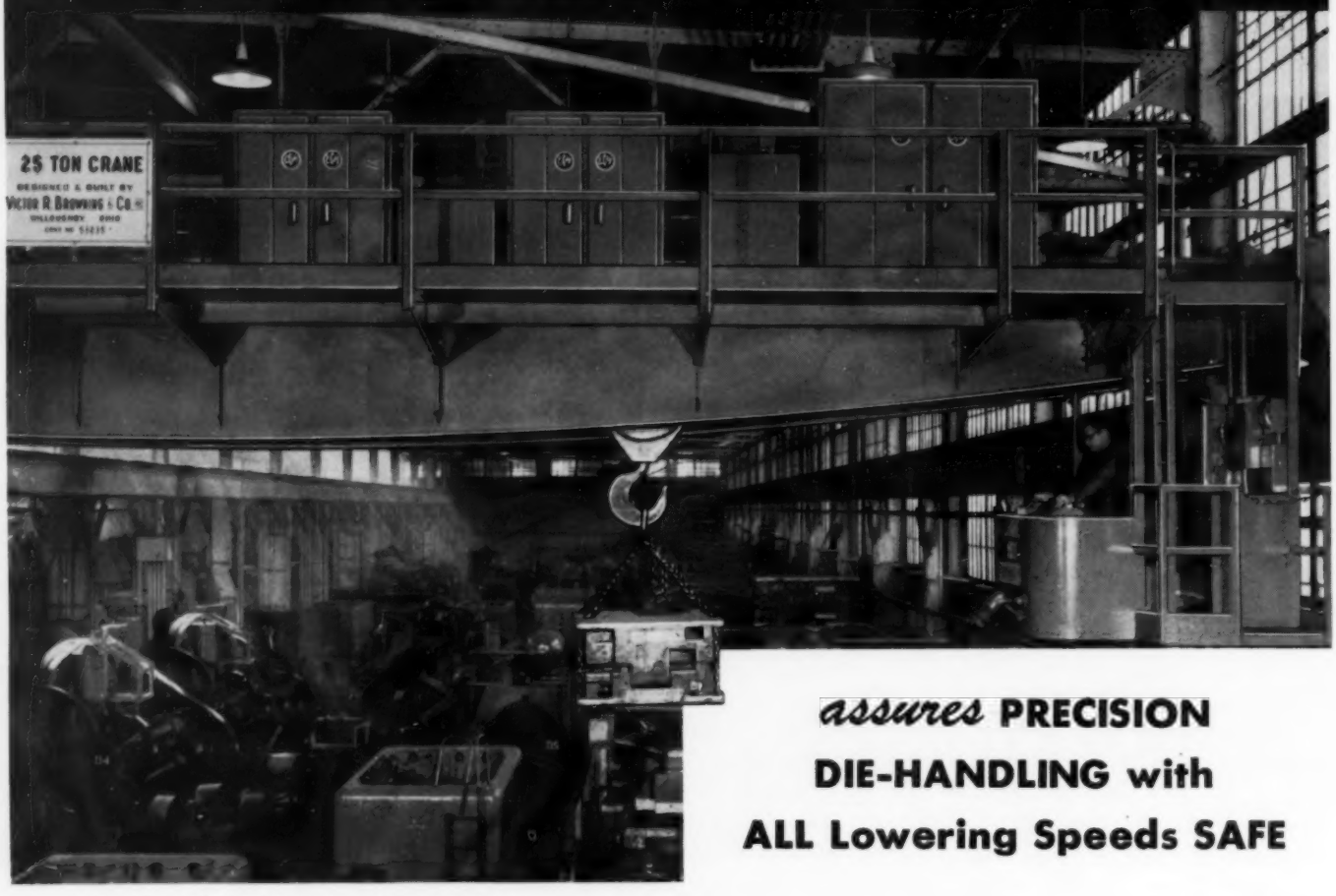
SUNOCO®

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY Philadelphia 3, Pa.

IN CANADA: SUN OIL COMPANY, LTD., TORONTO AND MONTREAL

EC&M 'EDDYMAG'® AC Hoist Control



assures PRECISION DIE-HANDLING with ALL Lowering Speeds SAFE

® Registered EC&M Trade Mark — U.S. Patent Office

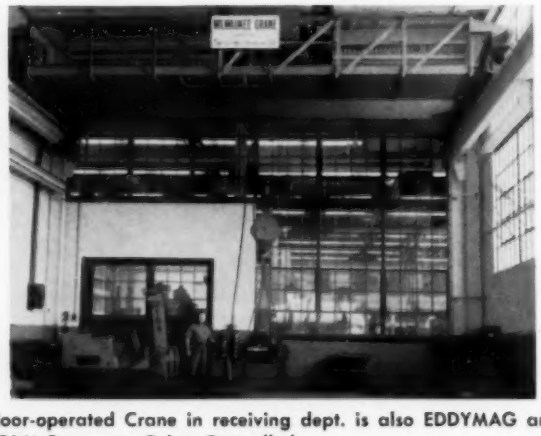
In this busy Press Metal Fabricating Dept. of a mid-west automobile manufacturer, EC&M EDDYMAG Hoist Control gives precise hook speeds for the many precision handling tasks encountered. Changing dies, or in the handling of raw and finished stock, a smooth and fast flow of production is guaranteed by this EC&M Controlled Crane.

By selecting this latest development in magnetic control for AC hoists operated by wound-rotor motors, plant management is assured of maximum safety with high output. In addition to EDDYMAG Hoist Control, EC&M Frequency Relay Controllers are used on the Bridge and Trolley motions, and an EC&M Manual-Magnetic Disconnect Switch provides a safe and easy disconnect means to remove power from the crane. Before buying cranes, investigate this simple, safer Control by EC&M.

For complete details on EDDYMAG Hoist Control write for Bulletin 9300.

BRAKING TORQUE ADJUSTED AUTOMATICALLY BY THIS SELF-REGULATING HOIST CONTROL.

When there is a demand for more braking to maintain the lowering of a heavy load at constant speed, EC&M EDDYMAG Control supplies the increased torque automatically. Any tendency for the motor to speed up increases the eddybrake torque to insure safer lowering. EC&M uses the simplest of Magnetic Amplifier to accomplish these results.



Floor-operated Crane in receiving dept. is also EDDYMAG and EC&M Frequency Relay Controlled.

8760

THE ELECTRIC CONTROLLER & MFG. CO.

DIVISION OF SQUARE D COMPANY

4498 Lee Road • Cleveland 28, Ohio

AS PARTNERS
IN YOUR PROGRESS

OUR EXTENSIVE RESEARCH – is a *plus* factor!

Our extensive program in carbon and graphite research is conducted by highly qualified chemists, physicists and technicians.

The scope of their specialized knowledge is a significant *plus factor* in the reliability that distinguishes GLC electrodes, anodes and mold stock.

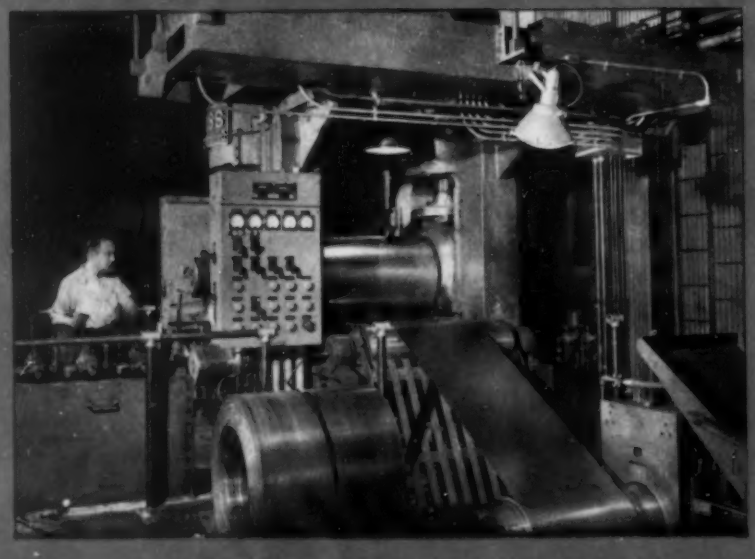
The high degree of integration between discoveries in our research laboratories, refinements in processing raw materials and improved manufacturing techniques is further assurance of excellent product performance.

ELECTRODE
GLC®
DIVISION

Great Lakes Carbon Corporation

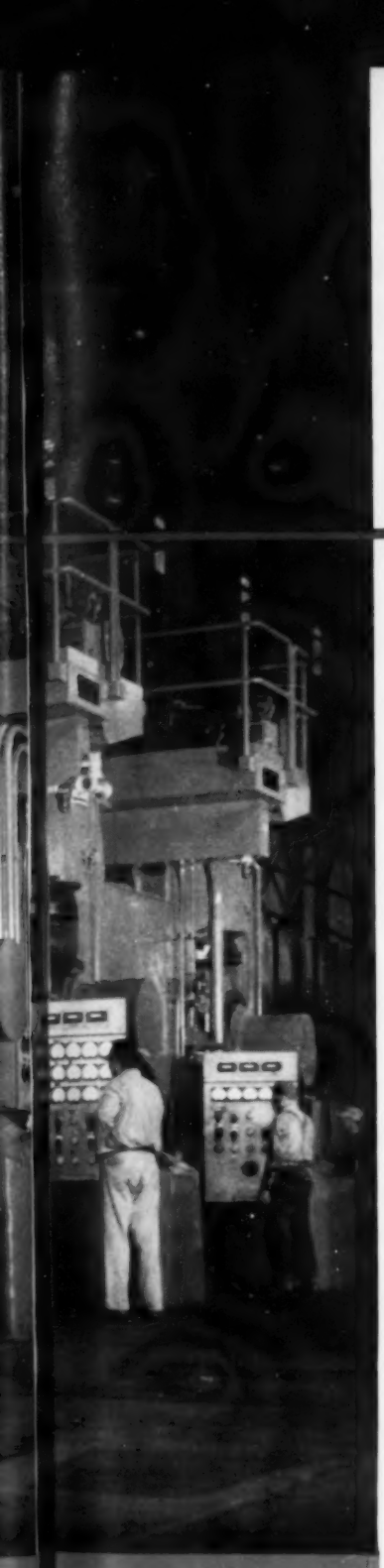
GRAPHITE ELECTRODES, ANODES, MOLDS and SPECIALTIES

ADMINISTRATIVE OFFICE: 18 East 48th Street, New York 17, N. Y. PLANTS: Niagara Falls, N. Y., Morganton, N. C. OTHER OFFICES: Niagara Falls, N. Y., Oak Park, Ill., Pittsburgh, Pa. SALES AGENTS: J. B. Hayes Company, Birmingham, Ala., George O. O'Hara, Wilmington, Cal. SALES AGENTS IN OTHER COUNTRIES: Great Northern Carbon & Chemical Co., Ltd., Montreal, Canada; Great Eastern Carbon & Chemical Co., Inc., Chiyoda-Ku, Tokyo, Japan



New Bliss 4-stand tandem mill at Empire Steel. Each stand is a 19" and 51" by 52" four-high mill. All entry and delivery equipment, including tension reel, coil buggy and belt wrapper were also made and installed by Bliss. Many of the rolls were supplied by Bliss' Mackintosh-Hemphill Division.

New Bliss 2-high 30" x 50" temper mill processes much of the output from the tandem. Its rated speed and coil capacity are the same as the big mill's.



Why Empire Steel picked BLISS mills for its new cold roll department...

Already known as a producer of hot rolled sheet and plate, Empire Steel Company, Mansfield, Ohio, has just completed a new cold roll department that ranks as one of the most up-to-the-minute in the country.

The key installation is a new Bliss four-stand tandem mill. Its 1866-feet-per-minute delivery speed on wide strip provides ample capacity for all Empire's foreseeable needs. A new Bliss single-stand two-high temper mill completes Empire's cold rolling facilities. Both mills are equipped with Bliss entry and delivery equipment capable of handling coils weighing up to 34,000 pounds.

Empire's selection of Bliss equipment was a logical one. Four years ago, Bliss engineered a complete hot strip mill for Empire, including the rebuilding of some existing equipment and the addition of completely new mills and accessories. The success of this modernization program had a strong influence on the company's decision to come to Bliss for its new cold rolling department.

Whether you need a complete new mill or advice about modification to your existing facilities, it will pay you to discuss your problem with a Bliss engineer. To get acquainted, why not write for a free copy of our 60-page Rolling Mill Brochure, Bulletin 40-A.

BLISS
SINCE 1857

is more than a name . . . it's a guarantee

E. W. BLISS Company, General Office: Canton, Ohio
ROLLING MILL DIVISION: SALEM, OHIO

Plants at Canton, Cleveland, Salem and Toledo, Ohio; Detroit and Hastings, Michigan; Midland and Pittsburgh, Pennsylvania; San Jose, California. Representatives throughout the United States.

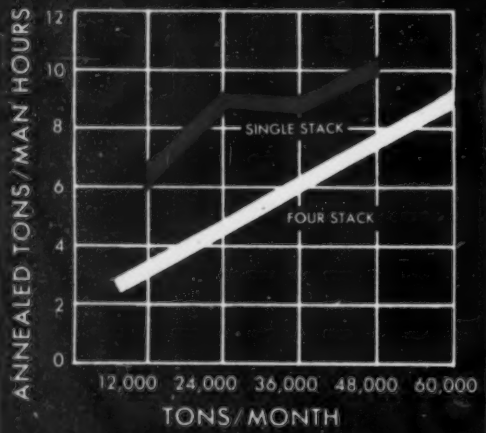
QUESTION:

What KIND of annealing furnaces create the best working conditions for most annealed tons per man hour?

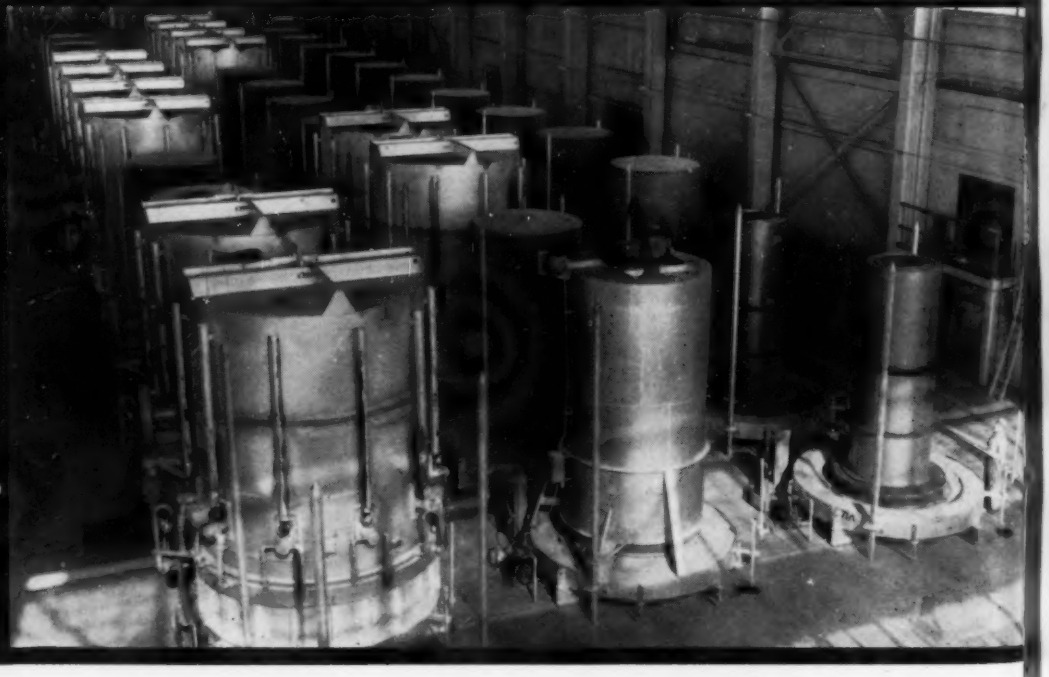
ANSWER:

THE LEE WILSON SINGLE STACK PORTABLE BASE FURNACES!

PROVED LOWEST LABOR COST PER TON



Based on studies of the most efficiently operated plants for both single stack and four stack furnaces.

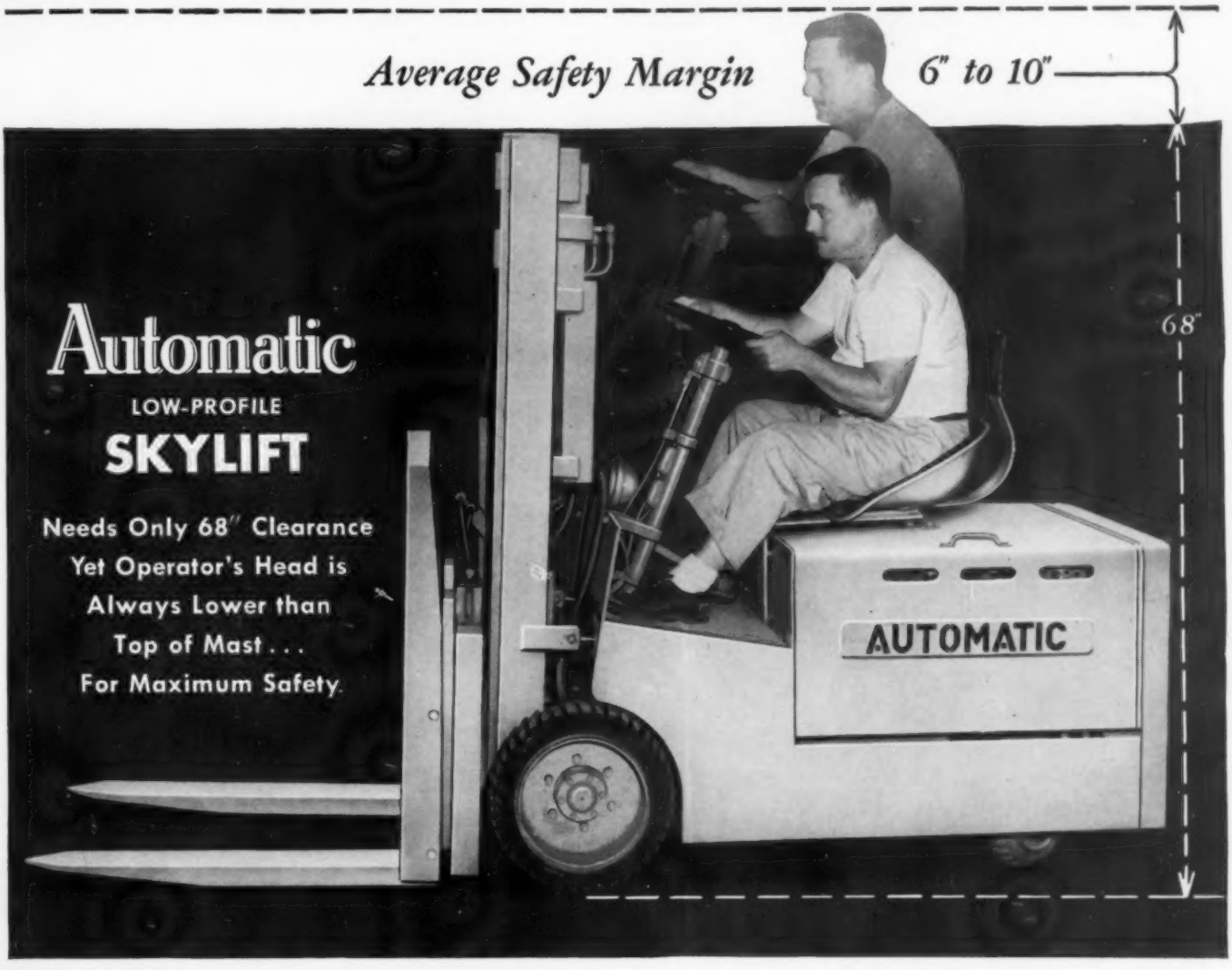


NO OTHER KIND OF INSTALLATION IS SO CLEAN, COMFORTABLE AND EFFICIENT AS THIS ALL SINGLE STACK ANNEALING DEPARTMENT!

Lee Wilson

ENGINEERING COMPANY, Inc.
CLEVELAND, OHIO

NO HEAD INJURY HAZARD HERE!



PLENTY OF CLEARANCE EVEN HERE — The 68-inch Mast easily clears header bar after entering or leaving a semi-trailer unit.

The AUTOMATIC Low-Profile Electric Skylift pictured above against phantom of a conventional fork truck shows operator's head well below top of the 68" fork mast. This permits operation in trucks and trailers with no danger of injury to driver's head. Another advantage is the high degree of maneuverability of all AUTOMATIC Trucks plus the added value of electric truck economy. Low center of gravity means better load control and greater stability. Single lift is 53"; telescopic lift 102". Capacities 1000 to 4000 pounds. Mail coupon today for further information.

Automatic®

50 YEARS OF LEADERSHIP IN THE MATERIALS HANDLING INDUSTRY

Automatic WORLD'S LARGEST EXCLUSIVE BUILDER OF ELECTRIC-DRIVEN INDUSTRIAL TRUCKS

47 West 87th Street, Dept. B-6, Chicago 20, Ill.

Without obligation, rush me full information on the Low-Profile Automatic Skylift.

Company Name_____

By_____ Title_____

Address_____

City & Zone_____ State_____

Frequent Instrument Check-ups Prevent Emergencies

The economical way to protect your plant's investment in instrumentation is a Honeywell Periodic Service Plan. Under this plan, a Honeywell service specialist comes to your plant at regular intervals to—

— Check your Brown instruments and calibrate them against accurate laboratory standards.

— Inspect all moving parts, clean and lubricate them, and replace where necessary.

You get this kind of service performed regularly for your office equipment such as typewriters and calculating machines . . . for your automobile . . . and even for yourself by periodic check-ups by your doctor. You've learned that the ounce of prevention is a good investment. Well, the same philosophy applies to instruments, too. Keeping them in good condition is far more economical than waiting for emergencies to throw production schedules into a tailspin.

Here, briefly, is what the Honeywell Periodic Service Plan does. It provides:

Periodic examination and adjustment by a factory-trained service engineer.

Automatic attention. Calls are made on a schedule that fits your own requirements . . . at a cost substantially lower than an equivalent emergency service call.

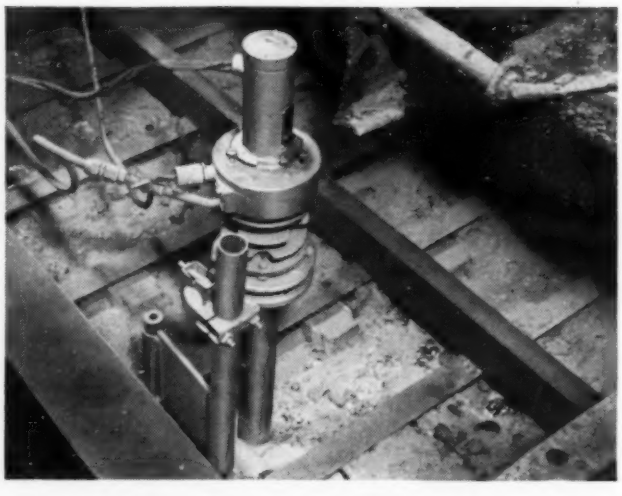
Continuous operation. Good instruments kept in top condition can be counted on for steady duty, without costly shut-downs. Well-maintained instruments last longer, too.

Increased plant efficiency. Greater reliability of operation builds confidence of plant personnel in their equipment.

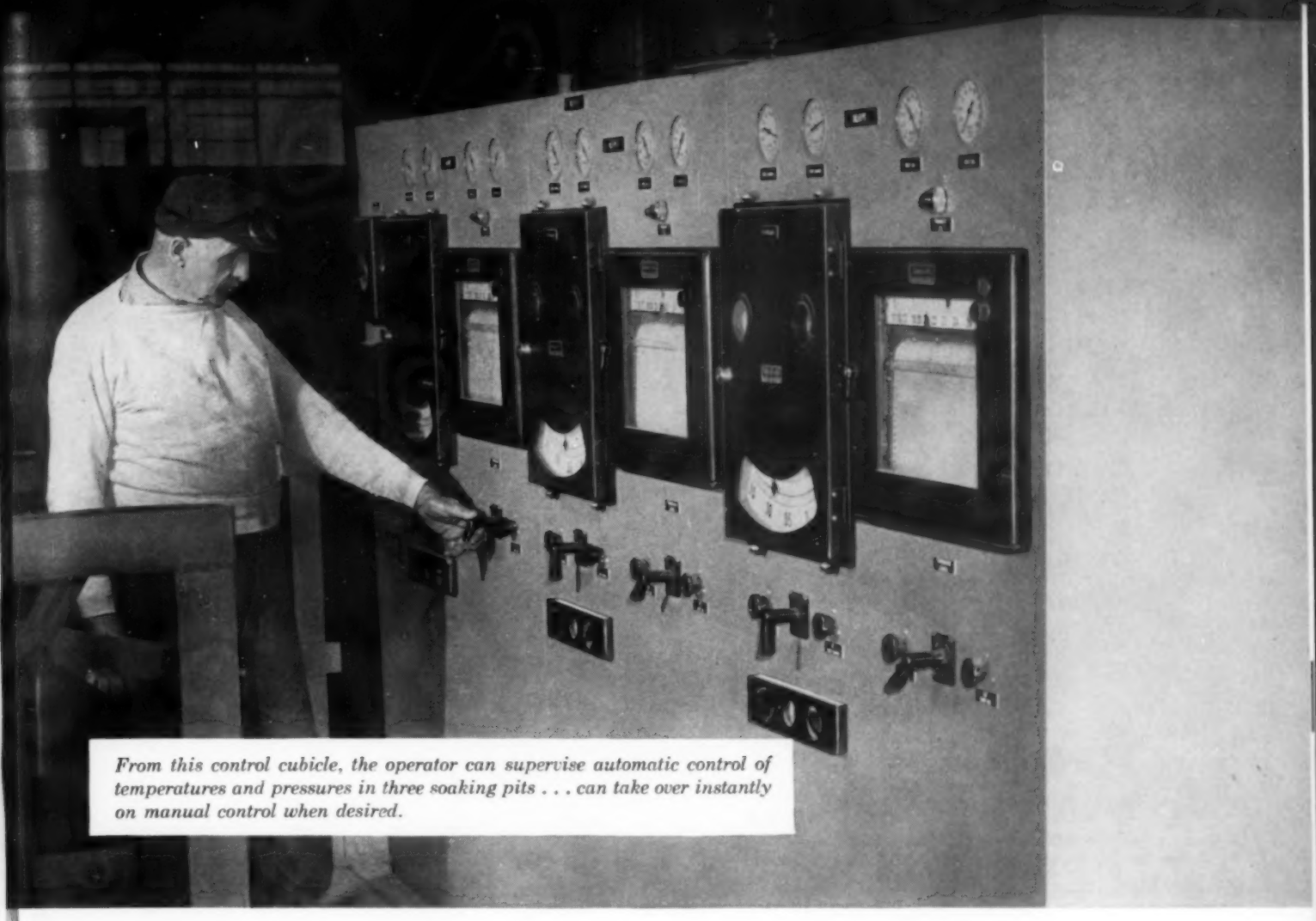
At any time, of course, you can count on prompt emergency service from any one of the more than 100 Honeywell service centers spotted throughout the United States and Canada.

The Plan is extremely simple. It costs remarkably little, and can pay real dividends in protection of your production schedules and your instrument investment. For details about how it can be applied to your own plant, call your local Honeywell office.

Brown controls for Lukens pits boost quality and



Soaking pit temperatures are detected by a ***Radiamatic*** *unit installed in the pit cover.*



From this control cubicle, the operator can supervise automatic control of temperatures and pressures in three soaking pits . . . can take over instantly on manual control when desired.

efficiency of steel production

MODERNIZING soaking pit operation by conversion from manual to fully automatic control . . . using Brown instrumentation . . . is helping Lukens Steel Company to make improvements in operation. Two regenerative soaking pits, each containing three holes, are now equipped with control centers from which temperature, draft and reversal timing are automatically regulated.

Mill personnel report that soaking temperatures are held more closely . . . heat distribution is maintained with more precision. Occasional overheat periods which inevitably occurred with manual control have been eliminated. Due to the improved temperature control on these units, more critical grades of steel are processed through them, helping to maintain high standards of quality.

Instrumentation for each pit includes an *ElectroniK* temperature controller, working with a *Radiamatic* element installed in the cover. A Brown Furnace Pressure Controller regulates draft to maintain the desired heat distribution and flow of combustion gases. At the turn of a switch, the operator can take over on manual control instantly, for emergency or start-up. Furnace reversal, normally automatically timed, can also be handled manually.

Modern instrumentation can help you to get top economy and productivity from either new or existing equipment. For a discussion of your own applications, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:** Write for Catalog 1531, "*ElectroniK* Controllers".

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

2 High Hot Strip Mill Table Rolls in plant of Dominion Foundries and Steel Ltd., Hamilton, Ontario, Canada. Arrows indicate location of J-M Clipper Oil Seals which protect bearings against dirt and other adverse conditions.

Engineers at Dominion Foundries and Steel Hot Strip Mill report:

"Bearings better protected— damaging dirt sealed out with Clipper Seals"

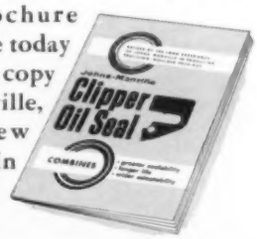
TABLE ROLLS of the 2 high strip mill at Dominion Foundries and Steel Ltd. must operate efficiently despite severe service conditions. Life of the Roll Bearings is constantly threatened by dirt and salt from strip mill operations.

To provide better protection, engineers replaced the original bearing seals with J-M Clipper Oil Seals. Long after this installation was made, Clipper Oil Seals are still providing far better bearing protection than the material formerly used. They seal out mill scale, salt and other foreign matter which might work into the bearing housings. They remain efficient despite high oil and air temperatures. They protect bearings by assuring clean lubrication.

Clipper Oil Seals offer many advantages wherever accurate fit, longer life and greater sealing effectiveness are required. These precision-moulded oil seals provide easy installation because the tough, dense heel affords just the right amount of rigidity for a press fit in the cavity . . . while the flexible lip, held in light but positive contact with the shaft by an especially designed garter spring, provides effective sealing at all times.

Made in both split and endless types, Clipper Oil Seals are available in a wide variety of designs, to meet practically any sealing requirement.

More details on this Dominion Foundries application as well as other interesting case histories, design data and complete information on all types of Clipper Seals are found in the new 28-page brochure PK-71A. Write today for your free copy to Johns-Manville, Box 60, New York 16, N.Y. In Canada, Port Credit, Ont.



JOHNS-MANVILLE PRODUCT

Johns-Manville CLIPPER OIL SEALS

Former Heat-Treating Time—28¼ HOURS
TOCCO Heat-Treating Time—30 MINUTES

Plus

$108 saved on every mill roll

This special mill roll hardening fixture is powered by two 200 KW, 3000 cycle TOCCO machines. Mill roll shown is 12" diameter by approx. 60" long.

with TOCCO* Induction Heating

When progressive engineers at The McKay Machine Company switched from conventional heat-treating methods to TOCCO induction hardening of their mill rolls, they achieved not only increased production but also important cost savings, and perhaps most important of all, a greatly improved product.

56 Times as Fast!

Formerly mill rolls required a 12-hour heat, a 15-minute salt brine quench, 12 hours tempering and a 4-hour cooling period. With TOCCO the whole job is done—and done better—in just 30 minutes—56 times as fast!

Here's Real Economy

Reduced furnace time saves $28.00 per roll. More important, grinding time is cut in half (saving $80 per roll) because TOCCO minimizes distortion and there's less stock that must be removed. Runoff used to be as much as ¼"—frequently requiring a separate straightening operation.

Product Improved

Because TOCCO "scans" the mill roll, i.e. heat treats it progressively, only a small section is at critical temperature at any one time. That's why distortion is minimized and little finish grinding is required. This means that TOCCO-hardened mill rolls have a *more uniform case-hardened depth* than possible with old fashioned methods which in turn means longer life and better performance.

• • •

Why not have a TOCCO engineer survey your plant to determine where TOCCO can reduce your costs, increase production speed and improve product quality?

THE OHIO CRANKSHAFT COMPANY

TOCCO

Mail Coupon Today

NEW FREE BULLETIN

THE OHIO CRANKSHAFT CO.
Dept. BB-2, Cleveland 5, Ohio

Please send copy of "Typical Results of TOCCO Induction Hardening and Heat Treating."

Name_____

Position_____

Company_____

Address_____

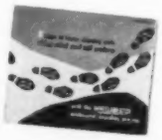
City_____ Zone____ State_____

TAKES LESS SPACE THAN PICKLING AT EMPIRE STEEL

descales carbon strip at 250′ per minute; slashes acid tank requirements 75%

A 16-wheel Wheelabrator mechanical descaling machine at Empire Steel Corporation in Mansfield, Ohio, cleans 250′ of carbon strip a minute and has eliminated all pickling except a 13-second immersion in a tank only 60′ long. The Wheelabrator is 66′ long and does cleaning that would require 250′ of tanks for straight pickling. This eliminates 75% of acid requirements and reduces acid disposal problems and tank maintenance. In addition, the matte finish imparted by Wheelabrating enhances the cold working properties of the metal. The high cleaning capacity of Wheelabrator equipment in a relatively small area means savings in floor space for new lines and permits increase in capacity of existing lines in the floor space presently available.

For more information on Wheelabrator blast descaling principles and savings, send today for Bulletin 864.



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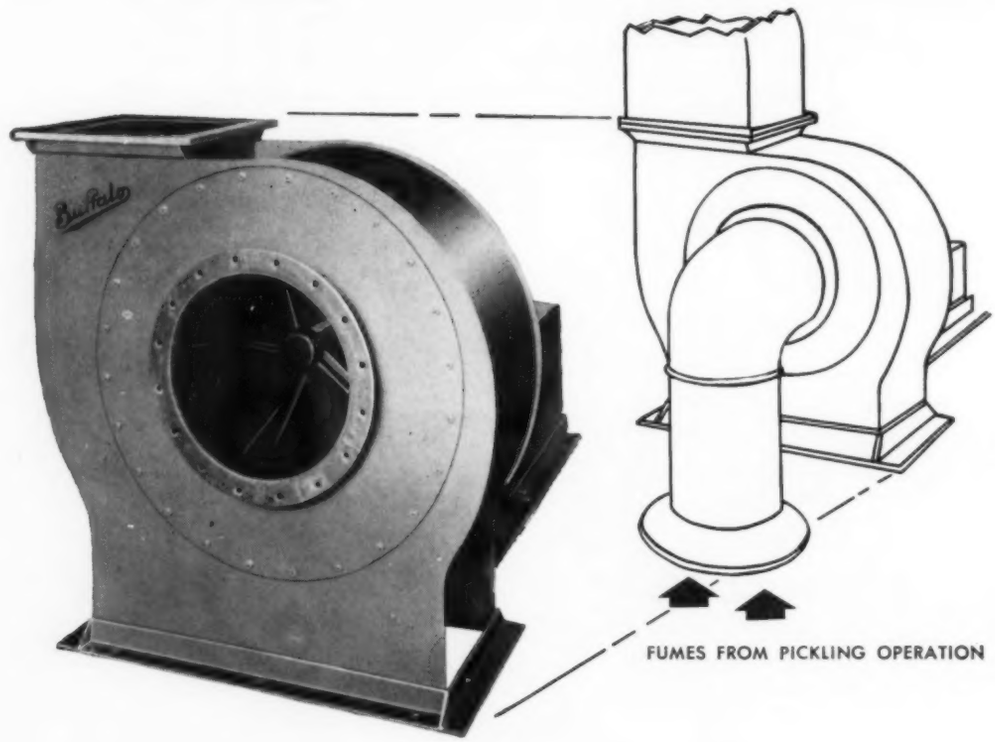
WHY "PICKLE" THE EXHAUST FAN, TOO?



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Actually, an ordinary metal exhauster handling pickling fumes is getting a continuous pickling — without rinsing and washing. These fan-eating fumes cause all-too-frequent expenses where they hurt most — in exhauster replacements.

"Buffalo" Rubber-Lined Exhausters are not new — they've been giving 3 to 12 times longer fume-handling service for the past 25 years. Whatever corrosive fume you handle, it never touches metal — because a protective rubber blanket is vulcanized to every square inch of the inside of the fan. "Buffalo" Rubber-Lined Fans more than pay for their extra cost in fan replacements, without beginning to count reduction of down-time. WRITE FOR BULLETIN 2424-E and see the many "plus" features that add up to the famous "Buffalo" "Q" Factor*, or extra value.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

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TIMKEN® bearings ended lubrication headaches on this hot mill 29 years ago

WHEN Wheeling Steel purchased this hot-strip mill in 1927, they specified Timken® tapered roller bearings for the roll necks on the work rolls and back-up rolls. These bearings have given extremely satisfactory service for the past 29 years while using economically applied, low-cost grease for bearing lubrication.

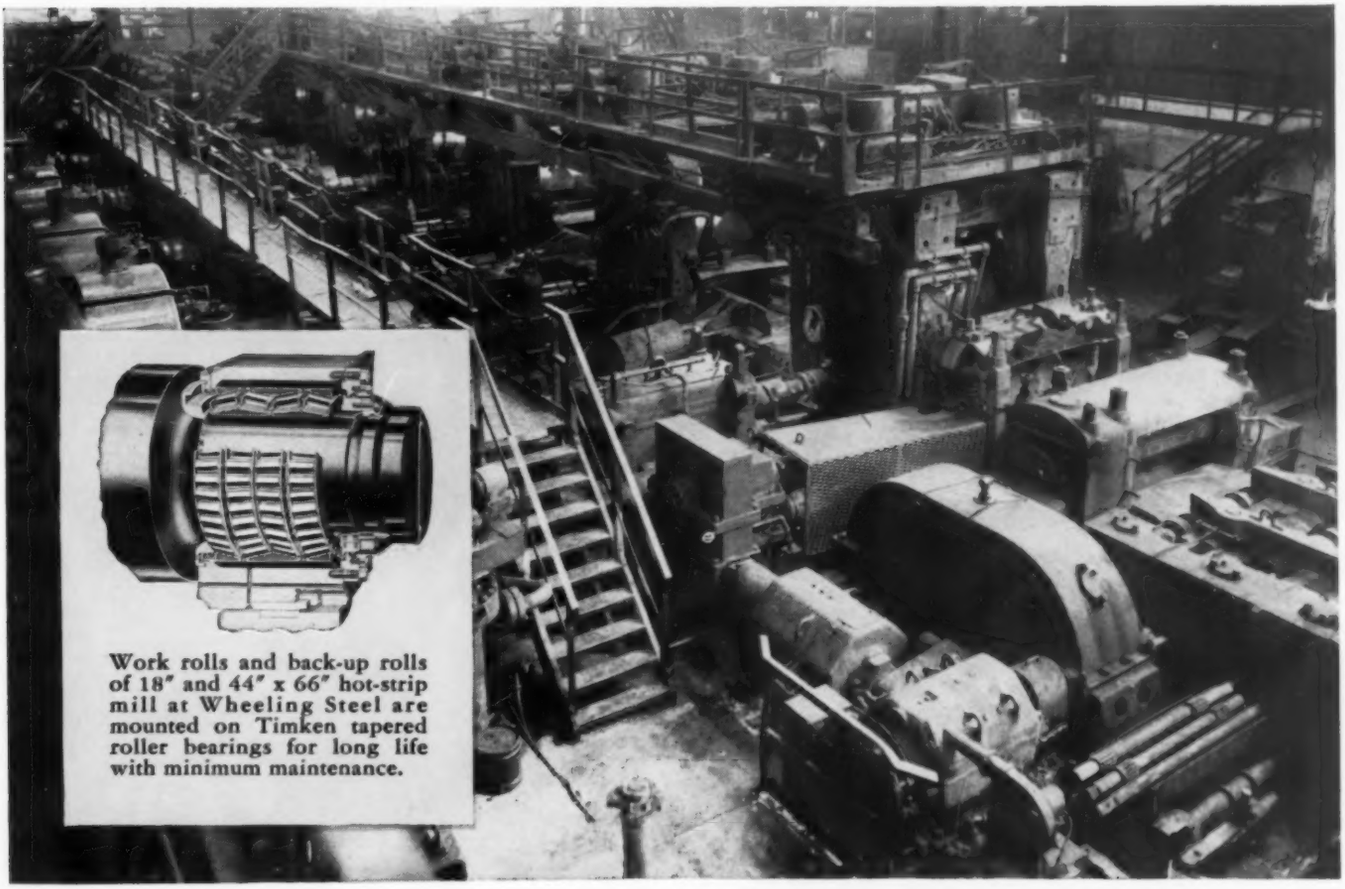
Their experience with grease-lubricated Timken bearings proves that there's no loss of lubricant during roll changes. Moreover, rolls can be changed in less time. And Timken bearings make closures more effective and reduce loss of lubricant because they keep the roll neck concentric with its chock.

Using Timken bearings will simplify mill designs all around. No special thrust units are needed because Timken bearings take both radial and thrust loads in any combination.

Timken bearings have exceptionally low frictional resistance—the result of true rolling motion based on proper geometric design and precision manufacture. This low friction reduces starting resistance and permits mills to accelerate more rapidly. Higher mill speeds are possible. Skidding or scuffing between work roll and back-up roll is reduced.

Timken bearings can be applied to machinery of any type to make it run better and last longer. Look for the trade-mark "Timken" on the bearings in the machines you buy or build. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



Work rolls and back-up rolls of 18" and 44" x 66" hot-strip mill at Wheeling Steel are mounted on Timken tapered roller bearings for long life with minimum maintenance.

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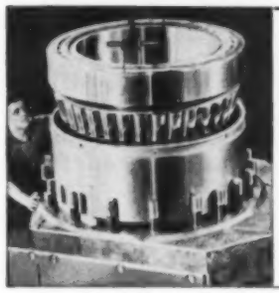

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By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . . patents reviewed cover period September 20, 1955 through October 11, 1955 . . . .

SMELTING WITH REDUCED AMOUNTS OF COKE

▲ U.S. 2,719,083, issued September 27, 1955 to Edmund S. Pomykala, describes a method for smelting iron with natural gas or oil replacing part of the normal coke requirement.

The furnace is loaded with smelting burden as at present, except that the coke content of the charge constitutes 40 to 80 per cent by weight of the fuel required to produce smelting. The remainder of the smelting fuel consists of hydrocarbon gases which are mixed with air and introduced into the furnace.

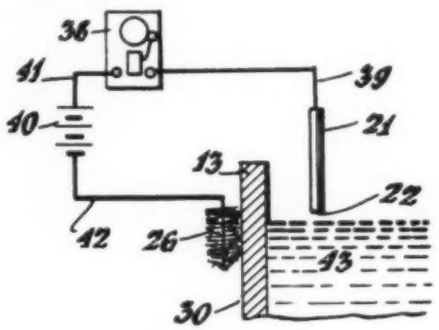


Figure 1

At the start of the process the fires are started in the usual manner and the furnace is brought up to smelting temperatures on air blast alone, at about 12 psi gage pressure. As this is taking place, the generation and heating of hydrocarbon gas is started by one of several cracking processes. The base stock is heated either in the liquid state or injected into a heated chamber in the vapor state and in contact with a suitable catalyst, whereby the heavier molecules are broken down into smaller units. Alternatively, the hydrocarbon gas may be supplied in the form of natural gas.

When the smelting furnace is well heated and operating on full blast, it may then be switched over to hydrocarbon gas fuel.

The temperatures at the level of the tuyeres are slightly less than those produced in the conventional process and average from about 2000 to 3600 F. However at higher levels the interior temperatures in the furnace are higher than conventional temperatures and average from about 2 to 5 per cent above these conventional temperatures. These higher temperatures result in a higher efficiency of reduction of the ore and enable the reduction of other oxide ores which are difficult to smelt in the conventional process.

INCREASING THE STRENGTH OF STEEL BY WORKING

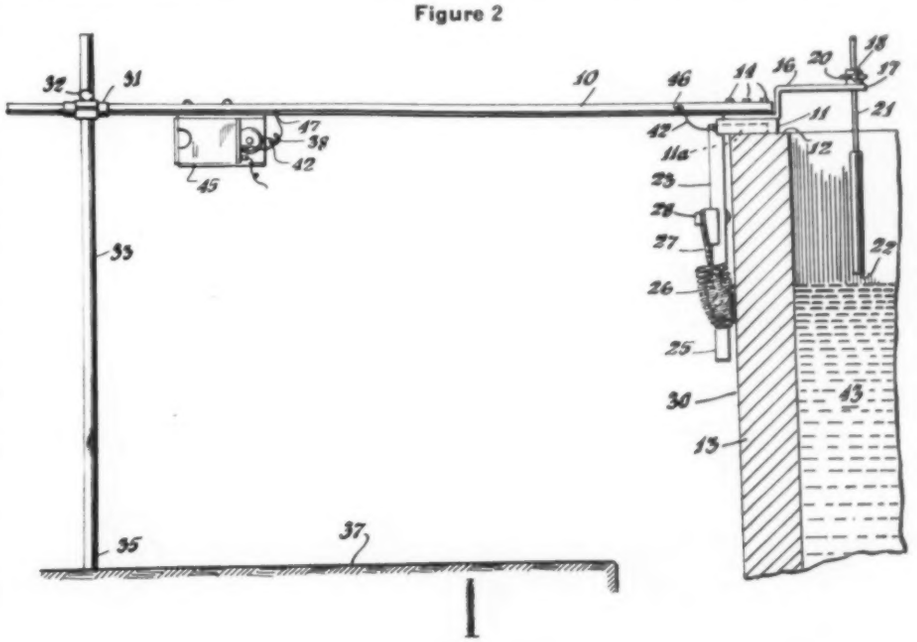
U.S. 2,716,080, issued August 23, 1955 to Johannes Schwarz, describes a process for increasing the strength of steel bars or tubes.

The steel pieces are first annealed and then colddrawn, thereby causing hardening of the surface area. Following this, the steel is cold compressed by hammering, pressing, or rolling, so as to cause deep hardening of the steel. This cycle of drawing and compressing may be repeated a number of times if necessary. Finally, the steel is annealed at 500-700 C to eliminate internal tension while maintaining the compression. The outer skin is thus not brittle as with drawn steels, and such a bar can be bent or otherwise deformed in the cold with less danger of breaking.

HEIGHT-RESPONSIVE SIGNAL FOR INGOT MOLDS

U.S. 2,719,896, issued October 4, 1955 to William J. Cain and assigned to Republic Steel Corp., describes a

Figure 2



device for determining when molten metal has reached a predetermined height in an ingot mold, and which may be moved readily and used with successive molds during an ingot pouring operation. The object is to determine the size of the ingots in advance so that they will meet desired weight specifications. For example, if the ingots are to be cut into a small number of relatively large units which must be of a given weight and an ingot is underweight, the last unit cut from the ingot will not meet the weight requirements, and, therefore, a large portion of the ingot must be scrapped.

The apparatus is shown schematically in Figure 1.

The apparatus is placed on mold 13 in the position shown in Figure 2, either before or during the pouring of metal. The electrode 21 extends into the top of the mold, and the end 22 of the electrode is maintained at the selected level by the plate 11 resting on the upper surface 12 of the mold. The leg 33 maintains the frame 10 horizontal and steadies the apparatus. In this position, the wire brushes 26 are resiliently pressed against the outside surface 30 of the mold 13.

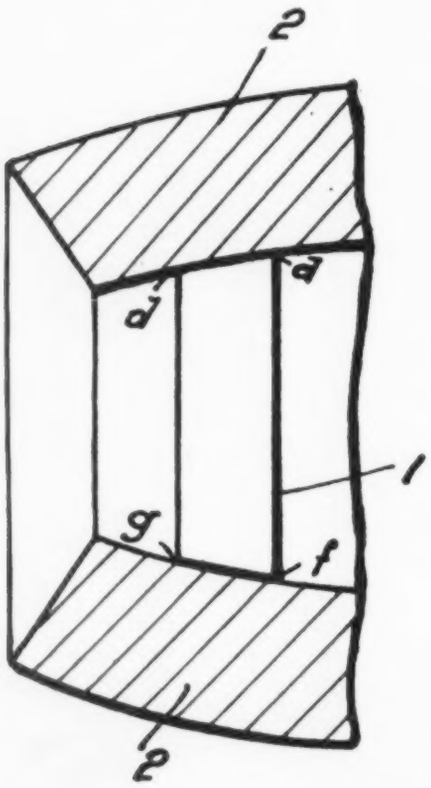
When the molten metal reaches the tip 22 of the electrode 21, the electrical circuit is closed which causes the alarm bell 38 to ring, thus notifying the operator to stop the pouring.

After one mold has been poured, the apparatus is withdrawn and positioned on the next mold to be poured and the cycle is repeated for succeeding molds of the same size which are to be filled to the same height.

The height of the metal to be poured in the mold is predetermined by setting the electrode 21 so that the lower end is the desired distance from the top of the mold when the plate is resting on said upper surface.

The outer surfaces of the molds are usually quite rough and are covered with foreign matter which may be electrically non-conductive so that a reliable electrical contact would not be assured if there was a single contact member. However, by employing the brushes 26 which present a number of possible conductors, a reliable electrical contact is established. In addition, the brushes have a scratching or scouring action when they are pressed into contact which assists in dislodging the foreign matter, and in keeping the ends or other parts of the brush wires clean, to assure effective contact with the mold surface.

Figure 3



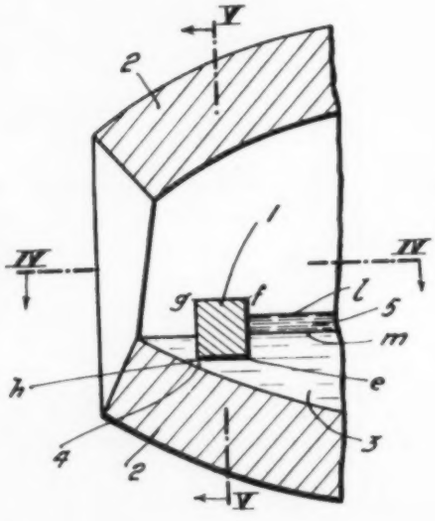
SKIMMER FOR HOLDING SLAG BACK WHILE POURING METAL

U.S. 2,718,389, issued September 20, 1955 to Rene Perrin and assigned to Societe d'Electro-Chimie d'Electro-Metallurgie et des Acieries Electriques d' Ugine, concerns the pouring of metals from tipping type furnaces.

The device provided consists of a body of refractory material, the apparent specific gravity of which is higher than that of the slag, but lower than that of the molten metal, designed for fitting against the walls of the pouring spout or nose of the vessel and for being retained in it when the vessel is tilted over for pouring.

The shape of the refractory float 1 is shown in Figures 3, 4, and 5.

Figure 4



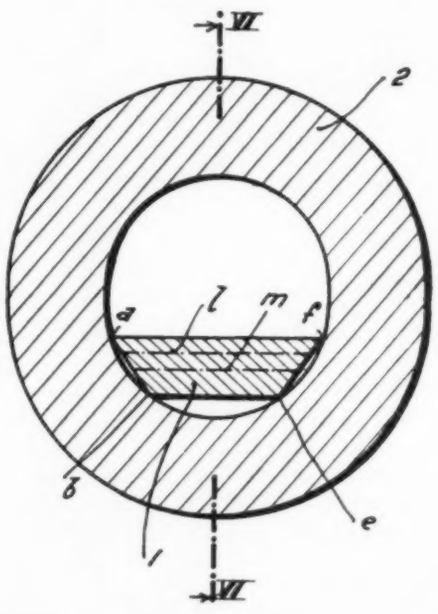
WATER COOLED FURNACE DOOR AND FRAME

U. S. 2,720,192, issued October 11, 1955 to George W. Humes, relates to water cooled doors and door frames for furnaces such as open hearth furnaces, melting furnaces, and heating furnaces.

It is customary to provide such furnaces with hollow water cooled door frames in the general form of a hollow arch, a door being mounted upon the frame. Due to the extreme temperatures to which these door frames are subjected, the hollow legs of the arch shape frame soon warp or bend. It is also common practice to provide straight guide ribs on the door frame, between which a straight edged door is mounted. These guide ribs, as well as the legs of the door frame, become warped and bent, causing the door to bind or stick and making operation of the door difficult if not impossible.

The structural features of the present invention are designed to avoid these difficulties, thereby preventing binding or sticking of the door.

Figure 5



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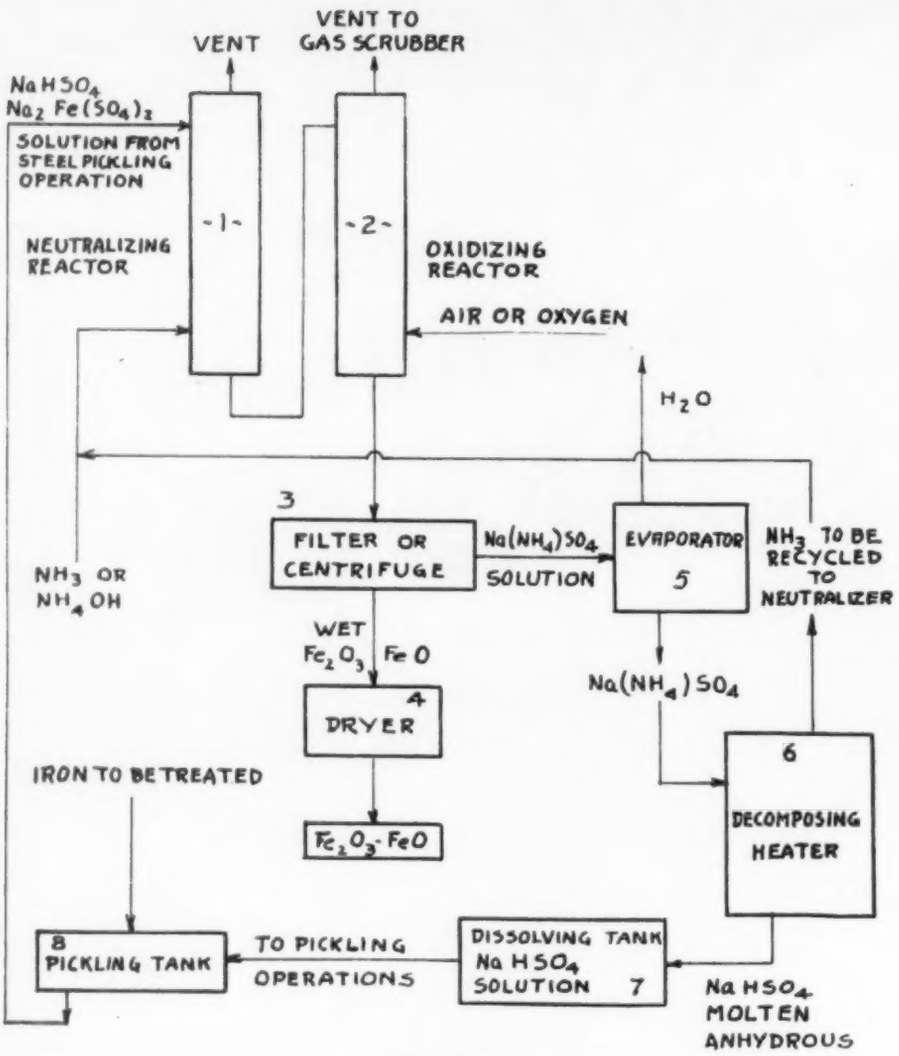


Figure 6

METHOD OF PICKLING IRON AND RECOVERING PICKLING AGENT

U.S. 2,720,472, issued October 11, 1955 to Clark O. Miller and assigned to Cleveland Industrial Research, Inc., describes a novel method for removal of oxide scale from ferrous metals and the recovery for re-use of the pickling agent. The pickling agent used is an aqueous solution of sodium acid sulphate.

The process is shown diagrammatically in Figure 6. The pickling operation results in the formation of ferrous sodium sulphate. The spent liquor is then cooled and treated with ammonium hydroxide in a neutralizing reactor 1. This results in the partial precipitation of the iron as a green gelatinous mass, difficult to filter. The slurry is now at a pH of from 7.0 to about 8.5. This slurry is then oxidized in an oxidation zone 2 by blowing with air. The iron is thus caused to precipitate as a black or brown iron oxide, probably ferroso-ferric oxide complex, which may be readily separated by centrifuging or filtration (3), and dried (4).

These reactions may be represented by the following equations.

$$Fe_2O_3 + Fe + 6NaHSO_4 \longrightarrow 3Na_2Fe(SO_4)_2 + 3H_2O$$

$$Na_2Fe(SO_4)_2 + 2NH_4OH \longrightarrow 2Na(NH_4)SO_4 + Fe(OH)_2$$

$$3Fe(OH)_2 + \tfrac{1}{2}O_2 \longrightarrow Fe_2O_3 \cdot FeO + 3H_2O$$

The remaining clear solution contains only the complex salt sodium ammonium sulphate with possibly a small amount of ammonium hydroxide. After filtration or separation of the iron oxide, this alkali metal ammonium sulphate liquor is then concentrated by evaporation in a single or multiple effect evaporator 5 until crystals of sodium ammonium sulphate or a mixture of crystals and saturated sodium ammonium sulphate solution is obtained.

The alkali metal ammonium sulphate thus obtained as a by-product may then be converted by heating to the alkali metal acid sulphate as shown by the equation:

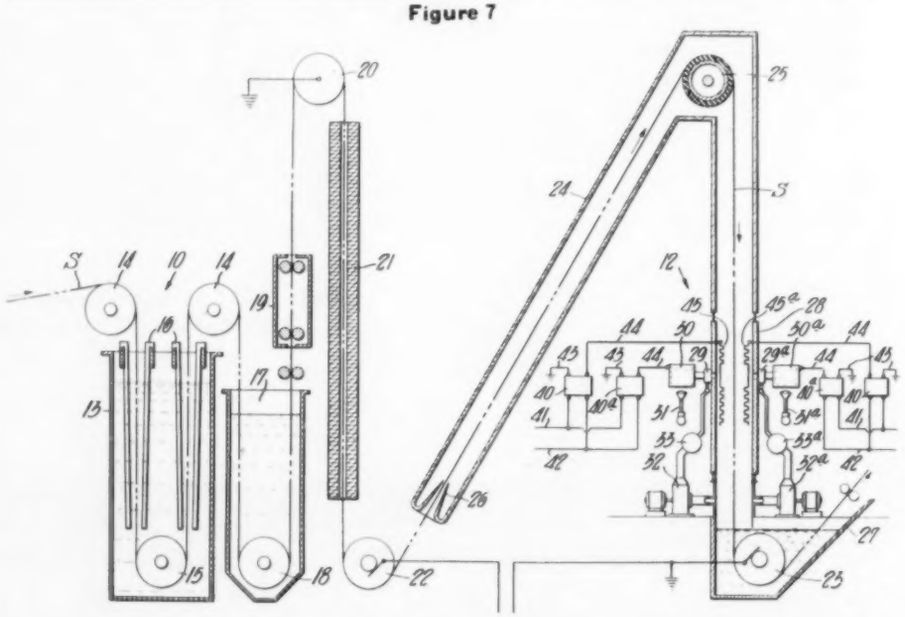
$$Na(NH_4)SO_4 \longrightarrow NH_3 + NaHSO_4$$

Both of these decomposition products are returned to the process, the sodium acid sulphate to the pickle liquor makeup tank 7, and the ammonia to the precipitation step.

The by-product of this process is the black oxide of iron. There may be handling losses of ammonia and alkali metal acid sulphate, but make-up supplies of each are readily available. Hence the disposal problems are eliminated and sulphuric acid may be successfully replaced in pickling processes.

(*Please turn to page 28*)

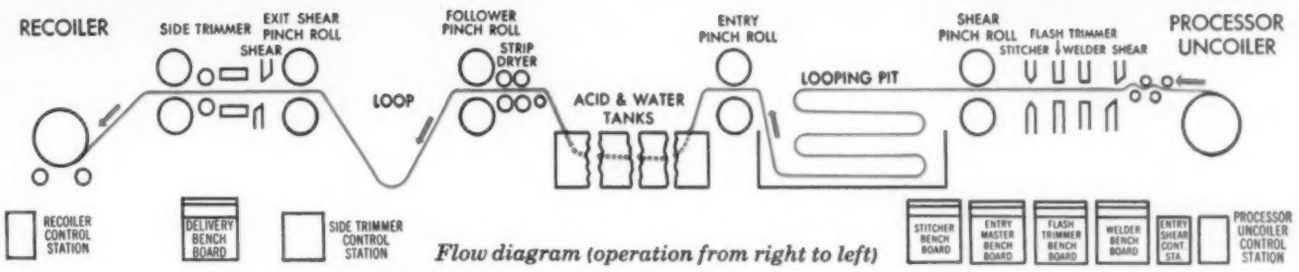
Figure 7



Continuous Pickling Line at Pittsburgh Steel is CLARK Controlled!

Exit section seen from recoiler

Entry section seen from processor uncoiler



Flow diagram (operation from right to left)

This Wean Engineering Co. continuous pickling line at the Pittsburgh Steel Co.'s Allenport, Pa. mill is powered by 7 DC strip-drive motors and 39 AC auxiliary motors totaling 1409 HP—all efficiently controlled by Clark apparatus.

Designed for a normal operating speed of 500 FPM, this 60 inch combination pickling and side trimming line consists of three sections. The entry section includes the processor uncoiler, shear, welder, flash trimmer, stitcher, and shear pinch roll. The center section includes the entry pinch roll, acid and water tanks, strip dryer and follower pinch roll. The delivery section includes the exit shear pinch roll, shear, side trimmer and recoiler. The control system employs current limit and voltage regulation in all three sections to provide for the most efficient utilization of the available horsepower.

CLARK engineered controls for processing lines are the cumulative result of years of engineering experience. These controls embody the latest circuit designs and devices and are continually being improved to keep pace with production and safety requirements as determined by modern mill practice.

For all types of Processing Lines CLARK engineering "know-how" provides you with dependable, complete control. Consult our nearest District Office for details.

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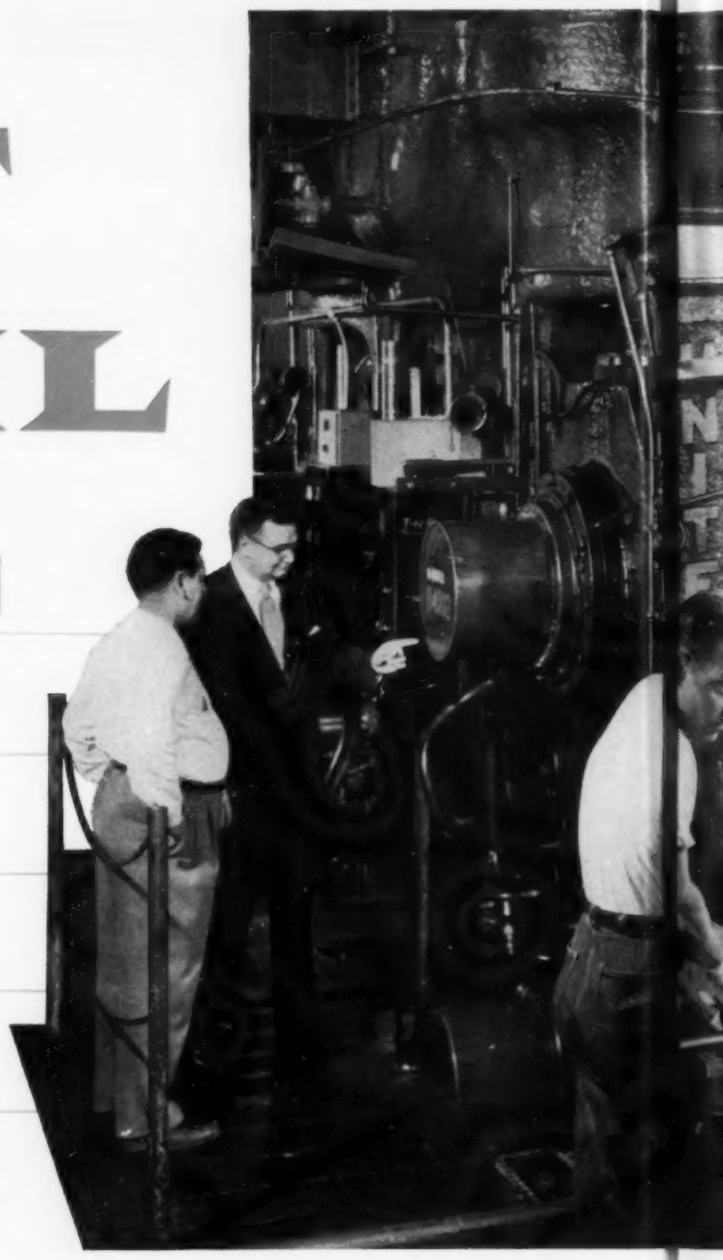

*says one of the larger brass mills in the United States**

The Morgoil bearings on the 4-high United Tandem mill at this plant have been lubricated with Gulf I-C Oil since it first went into operation in 1942. And there have been no bearing failures attributable to lubrication up to this time.

These bearings require the best possible lubrication to withstand heavy loads over a long period of time when rolling heavy brass strip. Gulf I-C Oil provides the effective lubrication that is needed. This stable oil has excellent water-separating characteristics and resists sludge formation. These important advantages — plus outstanding lubricating qualities — contribute to continuous operation and lower maintenance costs.

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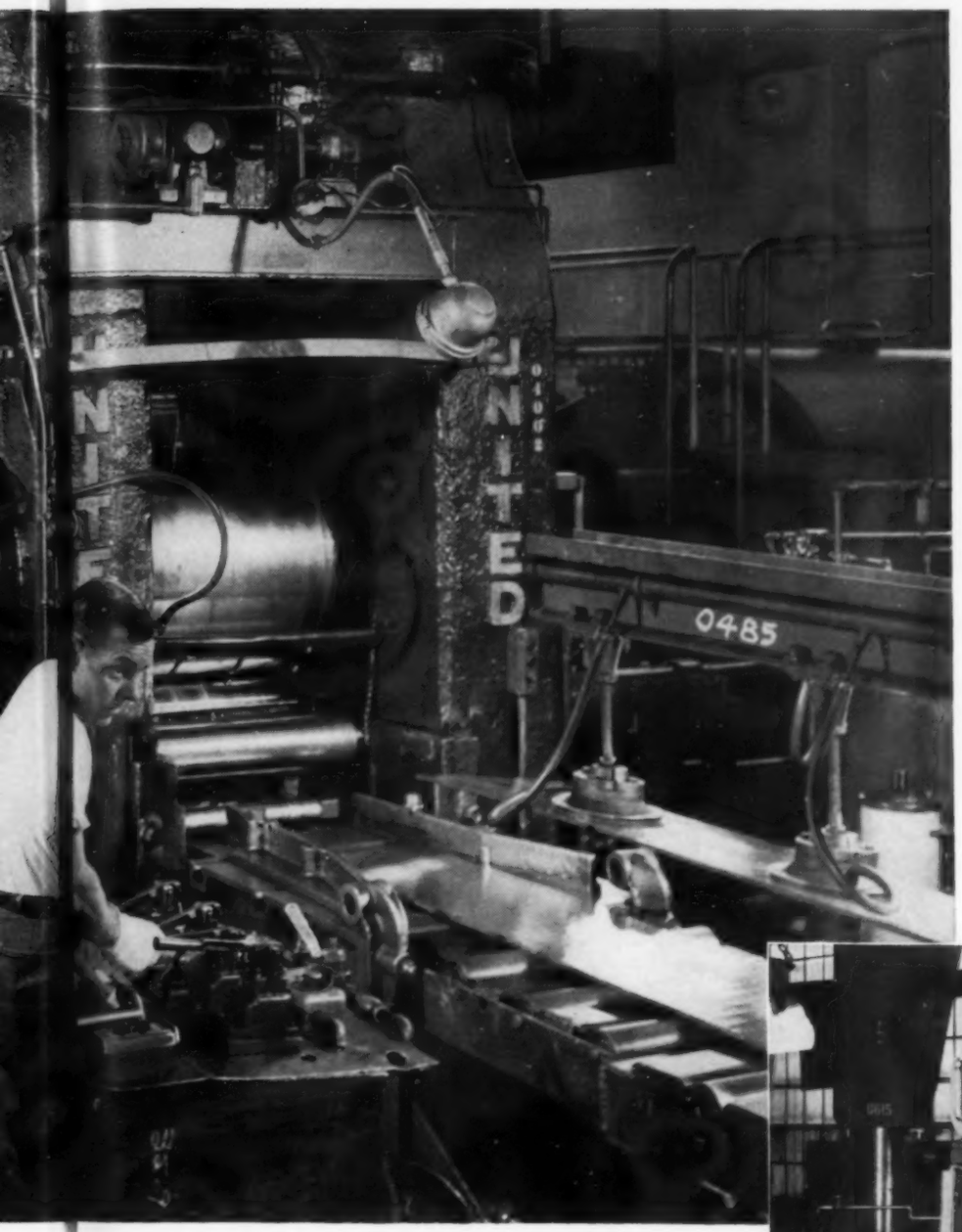

The Morgoil bearings in this 4-high United Tandem mill are lubricated with Gulf I-C Oil and have been for 14 years.

Single Stand 2-high rolling mill where Gulf I-C Oil contributes to smooth production. The roll oil in use is Gulf Stainless Metal Oil.

GULF

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(*Continued from page 24*)

METHOD FOR COATING STEEL STRIP

U.S. 2,719,820, issued October 4, 1955 to William S. Allen and assigned to United States Steel Corp., provides a method of tinning steel, which permits the deposition of coatings of any desired weight from 0.5 to 3.0 lb per base box, by a combined electrolytic and spray method.

The apparatus shown in Figure 7 includes an electrolytic cell 10 and a spray coating mechanism 12. A continuous steel strip S travels from left to right, passing first through the electrolytic cell and subsequently through the spray coating mechanism. Before reaching the former, the strip is cleaned and pickled in the usual manner. After discharging from the latter, the coated strip can be subjected to any of the usual finishing operations, such as surface chemical treatment and/or oiling.

The electrolytic cell 10 consists of a tank 13, conductor rolls 14, a sink roll 15 and tin anodes 16. The tank contains the plating bath. Since the electrolytic cell need deposit only a very lightweight coating on the strip (0.1 to 0.2 lb per base box) only a single cell is sufficient.

Between the electrolytic cell 10 and the spray coating mechanism 12, the strip passes down through a drag-out recovery tank 17, around a sink roll 18 in the tank, up through the tank and through a steam drier 19, over a grounded conductor roll 20 and down through a choke core 21. The strip then passes around two conductor rolls 22 and 23, which are situated at opposite ends of the spray mechanism, and which introduce alternating current to the strip for melting the coating. The purpose of the choke core is to limit the current which can flow back through the strip from roll 22, and the purpose of the ground on roll 20 is to prevent any of this current from entering the electrolytic cell.

The spray coating mechanism consists of an enclosed two-pass muffle 24 which is made of heat insulating material and has an electrically insulated roll 25 in its upper portion. The strip S travels from the conductor roll 22 through the first pass of the muffle, over the insulated roll 25, down through the second pass of the muffle, and around the conductor roll 23.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,718,048	9/20/55	Method for flaring tube ends	American Steel Foundries
2,718,070	9/20/55	Apparatus for cooling lumpy material	Metallgesellschaft Aktien gesellschaft
2,718,117	9/20/55	Nestable, flexible corrugated pipe	Armco Steel Corp.
2,718,455	9/20/55	Producing basic iron sulphate alloys	National Lead Co.
2,718,465	9/20/55	Iron-chromium titanium base alloys	Allegheny Ludlum Steel Corp.
2,718,482	9/20/55	Heat treatment of vanadium steel to improve its creep strength	Crane Co.
2,718,681	9/27/55	Method and compositions for the production of cores for use in metal casting	Ciba Ltd.
2,719,084	9/27/55	Special alloy for magneto-strictive applications	Collins Radio Co.
2,719,635	10/ 4/55	Cupola-charging apparatus	Deere & Co.
2,720,453	10/11/55	Preparing iron powder of improved electromagnetic and mechanical properties	General Aniline & Film Corp.
2,720,455	10/11/55	Reduction of oxides of iron	Alfred M. Thomsen
2,720,576-7	10/11/55	Electrical billet heater	Loftus Engineering Corp.

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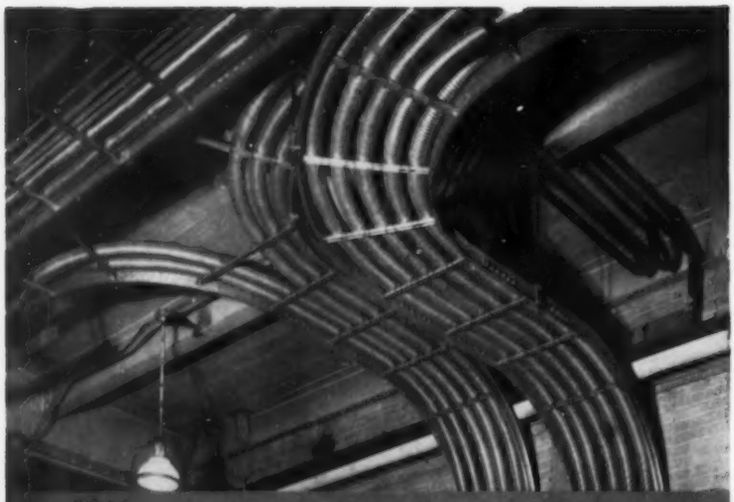

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OUTDOORS

rubber-insulated **LOXARMOR CABLES** save space, reduce cost

Considerable interest is growing throughout industry in Loxarmor (interlocked armor) Cables for use in locations where the maximum protection of a rigid conduit is not required. Okonite's interlocking Loxarmor covering makes the cable flexible and easy to train (minimum bending radius 8 times cable O.D.) and at the same time provides mechanical sturdiness. Installation costs are lower than for rigid conduit systems, and Loxarmor's accessibility makes it easier and cheaper to reroute or add circuits. Its compactness provides important space-saving features where runs must be installed around existing plant equipment. Loxarmor coverings can be supplied in galvanized steel, aluminum, bronze or copper.

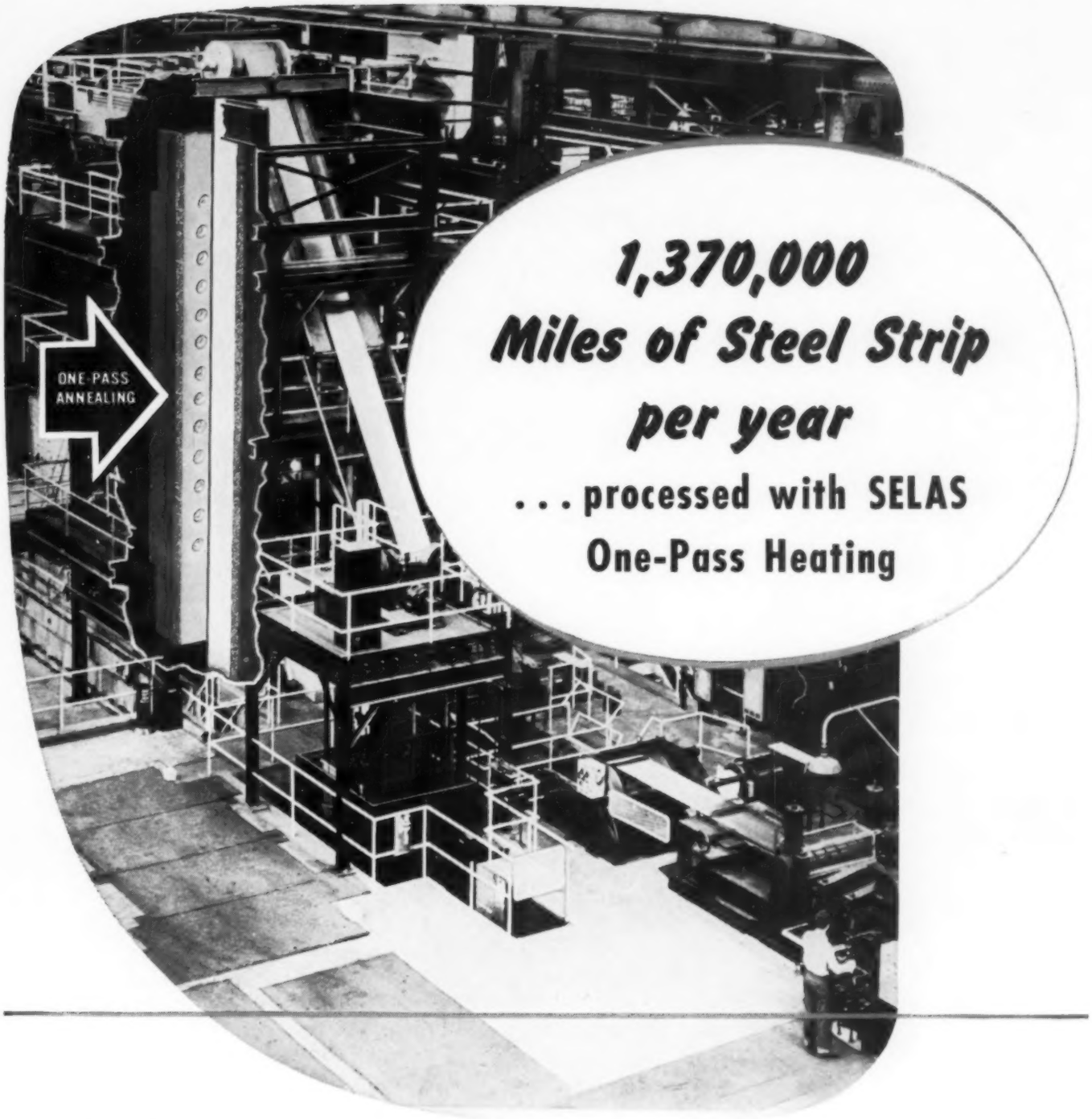
Okonite rubber-insulated Loxarmor Cables are insulated with Okonex, a butyl-base compound applied by Okonite's famous strip-insulating process. Vulcanized in a metal mold, the insulation forms a solid dielectric wall which has better moisture resistance and electrical properties than laminated varnished cambric insulations. The superiority of Okonex is indicated by its higher insulation resistance, lower dielectric loss, lower power factor and lower specific inductive capacity.

Okonex-insulated Loxarmor Cables are suitable for operation up to 15,000-volts and at conductor temperatures up to 85C. For complete information on Okonite Loxarmor Cables, including detailed splicing and terminating drawings and instructions, write for Bulletin IS-1090. The Okonite Company, Passaic, N. J.

Available with either copper or aluminum conductors

OKONITE *insulated cables*

2976



1,370,000 Miles of Steel Strip per year

. . . processed with SELAS One-Pass Heating

Enough steel strip to go around the world 55 times, is processed per year in Selas one-pass Gradiation furnace installations throughout the steel industry.

The Selas direct-fired heating principle is used in a number of continuous strip applications, including:

Bright annealing of steel . . . stainless steel annealing . . . tin reflow . . . galvanizing-annealing . . . preheat for galvanizing . . . preheat for annealing . . . bluing . . . special coatings . . . brass annealing.

In all these operations, radiant gas heat, precisely applied across the strip width, increases heating speed and produces unsurpassed uniformity in product quality.

- Compact single-vertical-pass design saves valuable floor space . . . avoids rolls in heated section and accompanying maintenance and product quality difficulties.
- Elimination of externally-prepared atmosphere in heating section reduces operating costs.
- Precise thermal control assures reproducible uniformity, regardless of gauge variations.

The same benefits are also being achieved in continuous annealing of nonferrous metals.

Our engineers will be glad to discuss how Selas Gradiation methods can be tailored to your strip-heating needs. Address Dept. 42.

SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

FOR BASIC
Open Hearth and Electric Steel Furnaces

HARBISON-WALKER

MAGNESIA RAMMING MIXTURES

H-W C MIX

Made From High Purity Seawater Periclase (92% Magnesia)

- **STABLE**—Excellent Volume Stability (shrinkage less than 1% when heated to 2910 F—ASTM C-113-46).
- **STRONG**—High strength over entire range of steel furnace temperatures accounts for its unusual resistance to erosion.
- **DENSE**—High density—low permeability.
- **EASY TO USE**—Cold rammed to finished contour of any hearth.
- **ECONOMICAL**—Provides durable monolithic hearths with low installation cost and increases furnace availability.

H-W MAGNAMIX

Made From Dead-Burned Washington Magnesite—Specially Sized—(80% Magnesia)

- **VERSATILE**—Dependable for new bottoms and especially adapted for both hot and cold maintenance jobs.
- **HIGH MgO**—Used without slag or scale additions, thus avoiding dilution of its high magnesia content.
- **DURABLE**—Excellent resistance to erosion accounts for its wide adoption as standard for repiping tap holes.
- **EASY TO USE**—Superior properties for patching large holes in banks and bottoms. Applied by air-ramming, gun placement or by hand in hot patching.
- **STRONG**—Strong cold-setting with crushing strength of 1500 P.S.I.

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
World's Largest Producer of Refractories
GENERAL OFFICES: PITTSBURGH 22, PENNA.

How a simple stud strengthens Morgan cranes!

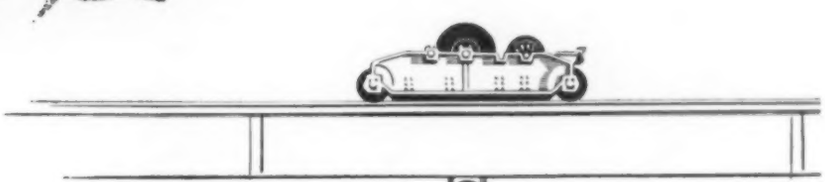
• *Stud welding* of bridge cover plates makes Morgan cranes structurally stronger . . . prevents corrosion inside the girder due to dirt and moisture leaking through holes in the plate . . . stops dangerous scale formation.

Former fabrication method of punching holes in the top plate and fastening rails with T-head bolts weakens the girder. With Morgan's method, stud welds are actually stronger than the parent metal.

Stud welding is still another example of the advanced design and construction features that make Morgan cranes the best in the business.

Performance records prove that Morgan cranes cost less to operate and maintain. Let our representative show you how to save the most by buying the best . . . Morgan!

By welding studs to cover plates, rails can be fastened to crane bridge without punching holes for T-head bolts . . . structural strength of the plate is protected. Static tension, torsion and impact tension tests prove the weld is stronger than the stud or parent metal.



The Morgan Engineering Company, founded in 1868, manufactures overhead electric traveling cranes, gantry cranes, charging machines, plate mills, blooming mills, structural mills, shears, saws, and auxiliary equipment.

THE MORGAN ENGINEERING CO. *Alliance, Ohio*

Wagner®
ELECTRIC MOTORS
...the choice of leaders in industry

New NEMA Frames
Standard and Explosion-proof

Type EP
215 Frame

Wagner Totally-Enclosed Fan-Cooled Motors

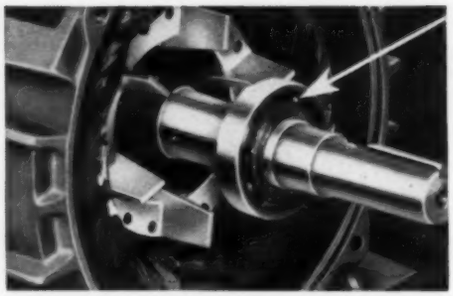
cut maintenance time and costs

Check the features of the new *Wagner Type EP Totally Enclosed Motor*. They spell the difference between needless expenditures in maintenance time and costs . . . and a definite savings in motor upkeep and repairs. You'll find that for general industrial use where dust, dirt, filings, abrasives, steel chips or moisture are present, the Wagner Type EP Motor gives steady, troublefree performance and longer service life.

Wagner Type JP Explosion-Proof Motor . . . has the same quality construction as the Type EP – plus added features which make it completely safe to operate where explosive dust, gases or vapors are present.

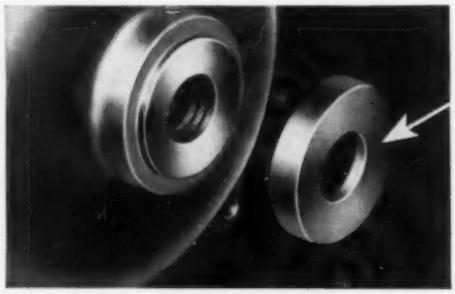
Both Type EP and JP Wagner motors are available in ratings up to 250 horsepower. For complete information, just call the nearest of our 32 branch offices, or write for Bulletin MU-203.

Wagner Electric Corporation
6483 Plymouth Ave., St. Louis 14, Mo.

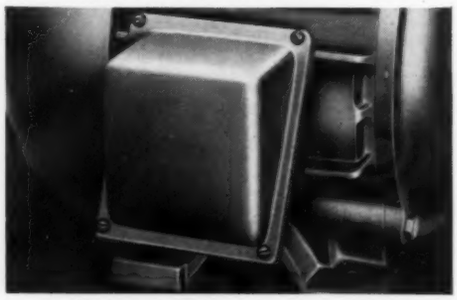


1 HEAVY-DUTY BALL BEARINGS—Highest quality bearings of more than ample capacity provide long, troublefree service.

2 BEARINGS CAN BE RE-LUBRICATED—Wagner motors can be re-lubricated when necessary to prolong bearing life.



3 BEARINGS STAY CLEAN—Both ends of these motors are equipped with running shaft seals, a machined collar mounted on the motor shaft.



4 EASY TO CONNECT—Large diagonally-split conduit box provides ample room for making connections. Leads are permanently identified.

5 NO GREASE LOSS—Bearing housings have effective seals to prevent escape of grease.

6 RIBBED FRAME—Ribs on the corrosion-resistant cast iron frames add mechanical strength and increase the surface area for more efficient cooling.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

M55-18

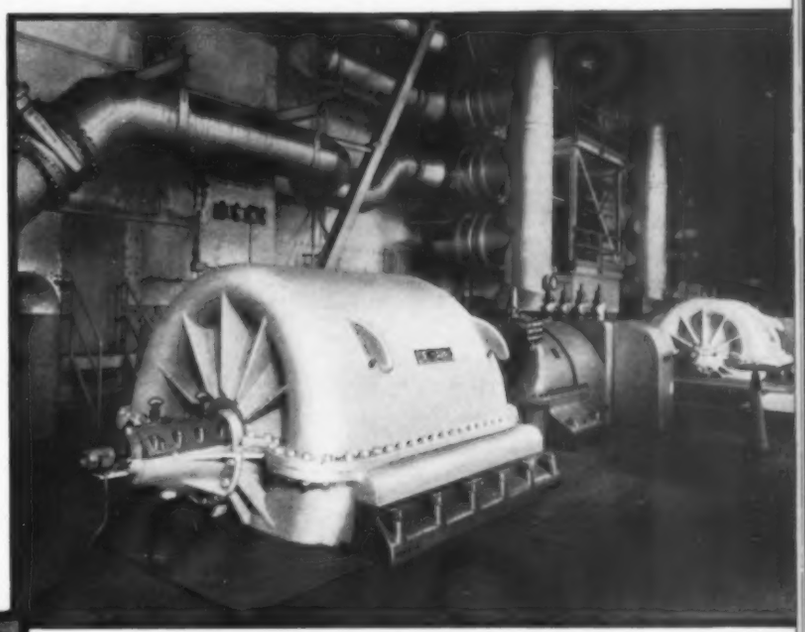
ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

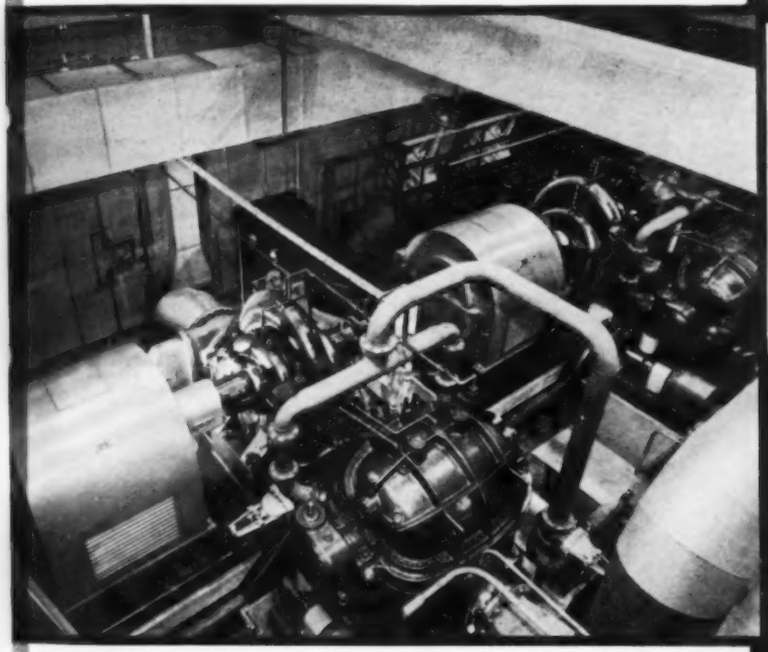
DE LAVAL
CENTRIFUGAL BLOWERS AND PUMPS

stay on the line for years at **Jones & Laughlin**

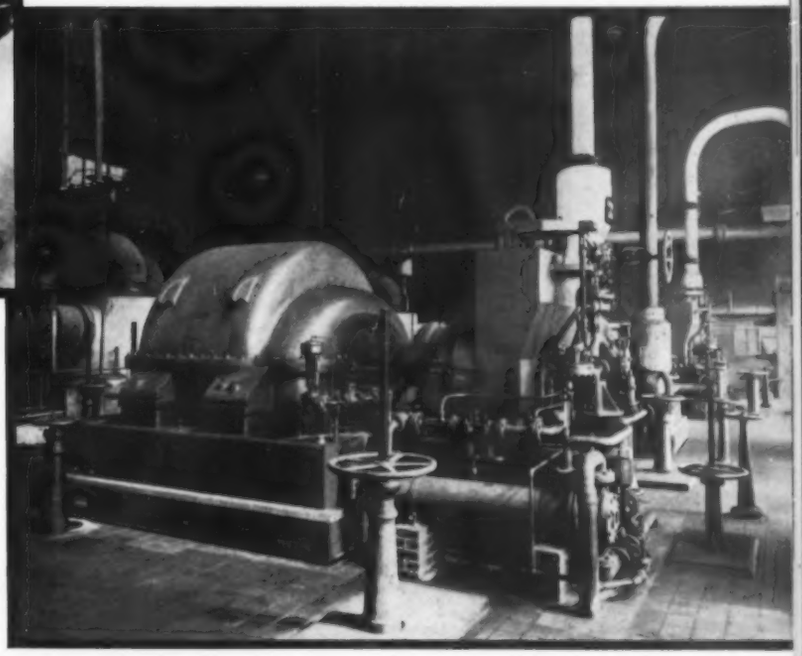
Jones & Laughlin reports: *"We have been using De Laval equipment for many years, and from our experience we have learned that De Laval blowers and pumps are inexpensive to maintain. Service is excellent. We can get spare parts quickly."*

Three De Laval 22,000 gpm motor-driven pumps are on the job at Jones & Laughlin Steel Corporation in Pittsburgh, Pa. These units are used to pump river water to the open hearth and general mill. Installed in October 1951, these three pumps "have not had any downtime at all since their installation except for periodic inspections," Jones & Laughlin reports.





These two De Laval centrifugal blowers, each rated at 100,000 cfm, are in use 24 hours per day, seven days per week except for a yearly inspection period. Since installation, there has been only 24 hours downtime in one of these blowers with a maintenance cost of about $400. "That's very little for this type of equipment," says the Jones & Laughlin blower room foreman.



This is one of three De Laval gas exhausters, operating at 48,000 cfm around the clock. Two of these units can handle maximum capacity; the third is used as a spare. Jones & Laughlin says, "Without good gas exhausters you would have to 'bee hive' (open the top and permit the gas to go free), thus losing our by-product."

Send for Bulletin 0504

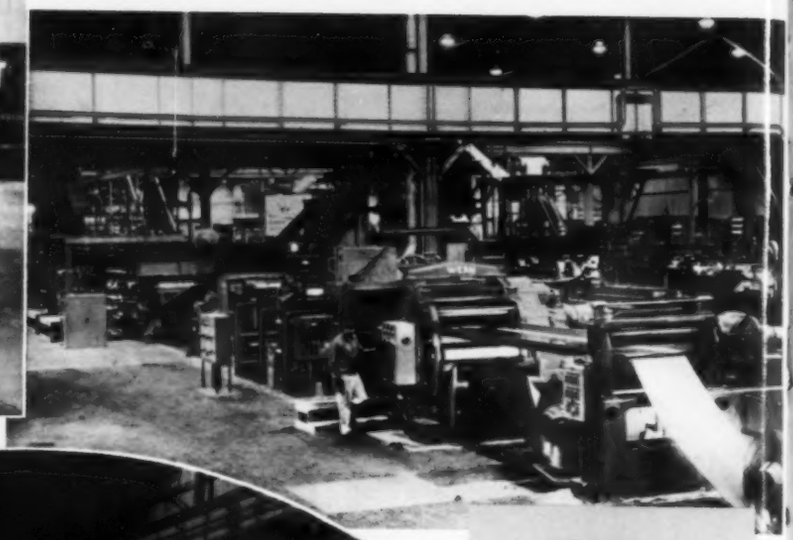
DE LAVAL *Pumps and Blowers*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey

GARY

Ferrostan

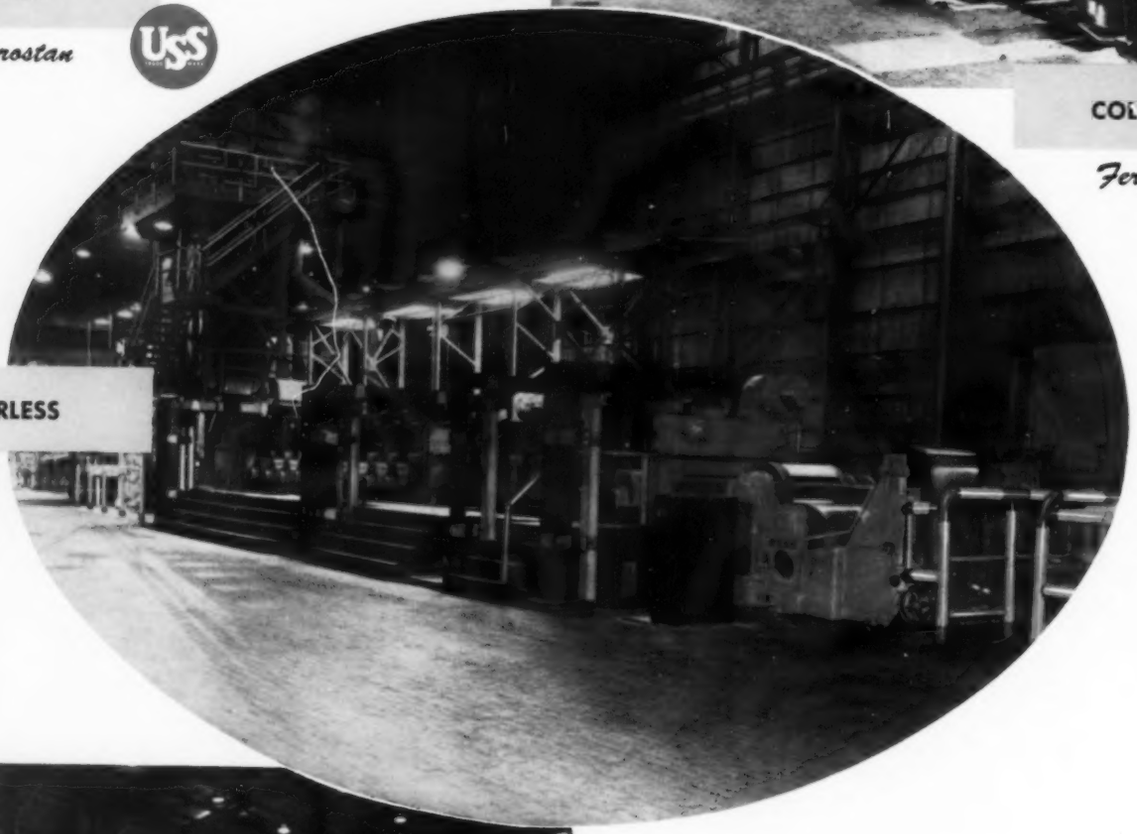
USS



COLUMBIA

Ferrostan

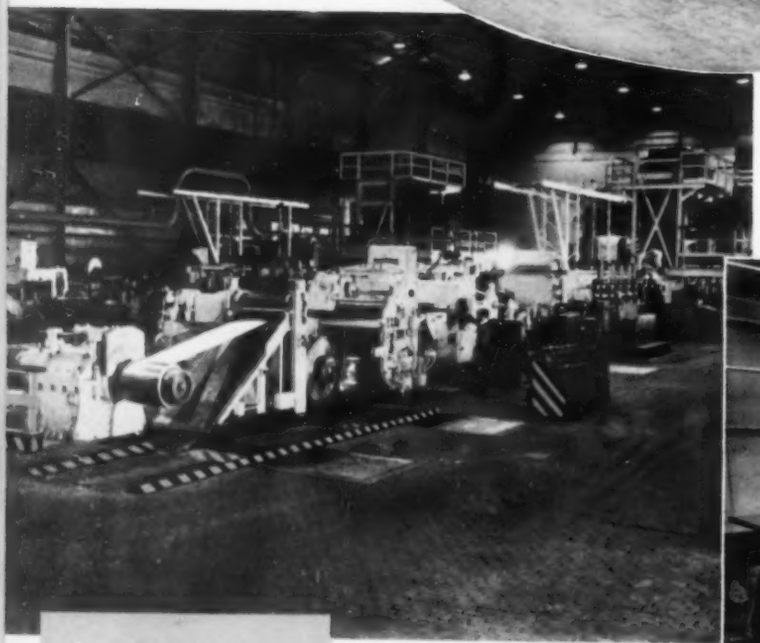
USS



FAIRLESS

USS

Ferrostan



IRVIN

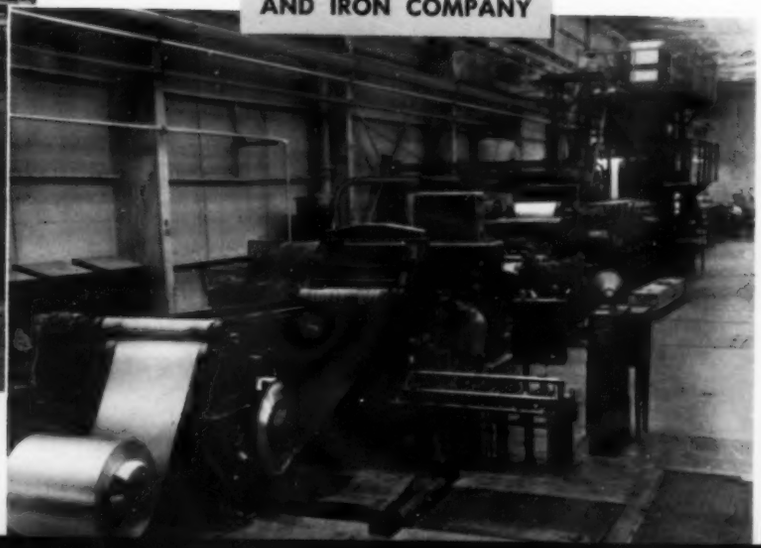
Ferrostan

USS

USS

Ferrostan

TENNESSEE COAL
AND IRON COMPANY



WEAN

. . . has designed and built 37 continuous electrolytic tinning lines . . . . . .

. . . In addition to the 37 continuous electrolytic tinning lines already designed, built and delivered by Wean to leading tinplate producers the world over — ~~four~~ five more are now in various stages of completion.

FORTY-TWO LINES IN ALL

(Ferrostan, Halogen, Alkaline)

Here's engineering experience and "know-how" beyond comparison. If your plans include TIN-PLATE facilities, confer first with the world's most experienced designer and builder.

WEAN

ENGINEERING COMPANY, INC.

Warren - - - - - - - - Ohio

WHEELING *Ferrostan*

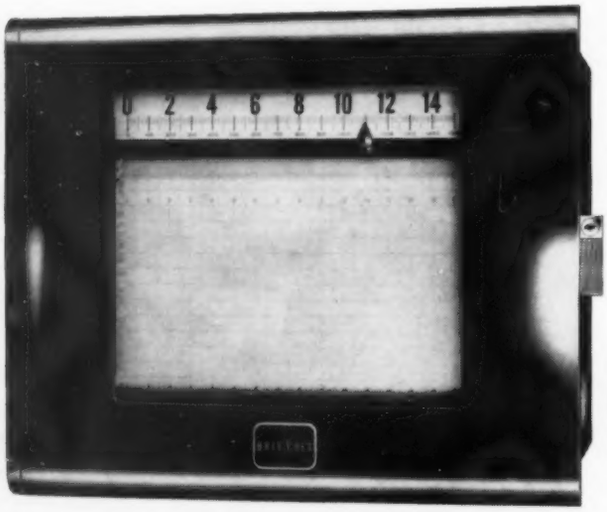
KAISER *Ferrostan*

WEIRTON *Halogen*

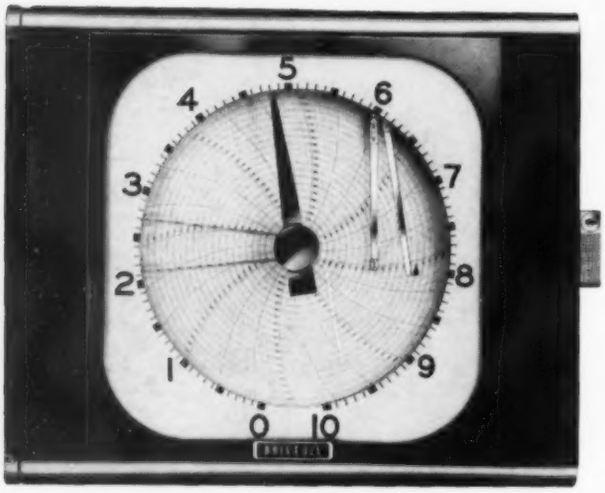
JONES & LAUGHLIN *Halogen*

SPECIALISTS IN SHEET, STRIP AND TIN MILL EQUIPMENT

WHAT'S NEWS AT BRISTOL . . .



Three reasons temperature control is better with Bristol

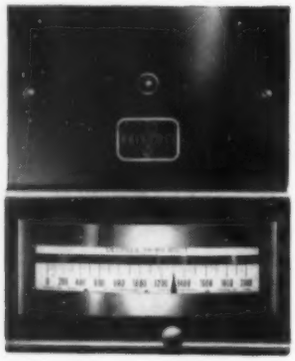


FIRST TWO REASONS are Bristol's Electronic Dynamaster Potentiometers with strip chart or round chart. Here's why:

No-Batt Continuous Standardization in these instruments eliminates need for dry cells. Result: No interruption in operation for standardization, no batteries to replace.

Recorders for every requirement – single-pen, two-pen, and multiple-record (up to 24 points)

Electric and pneumatic controllers for every furnace and oven control mode, including *electric controllers* for on-off, proportional-input, 3-position, proportional, proportional plus automatic reset, and time-program control; and *pneumatic controllers* for on-off, proportional, proportional plus reset, and proportional plus reset plus derivative control.



THIRD REASON: Bristol's Free-Vane® Electronic Pyrometer Controller. No relay chatter with this controller! Bristol's thyratron-operated relay puts a stop to that. Minute changes in temperature – less than 0.003" on scale – close or open the relay with positive trigger action. Available in thermocouple and radiation pyrometer controllers in ranges up to 4000F. New high-torque, rugged millivoltmeter gives greater accuracy and a sensitivity of 15 ohms per millivolt. Separate plug-in control units, variety of control modes available.

Get the whole story on these three rugged Bristol Furnace and Oven Controls. Write for free 48-page Bulletin P1260 today. It contains specifications, control diagrams and prices for every type of automatic heating control. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.
5.40

BRISTOL

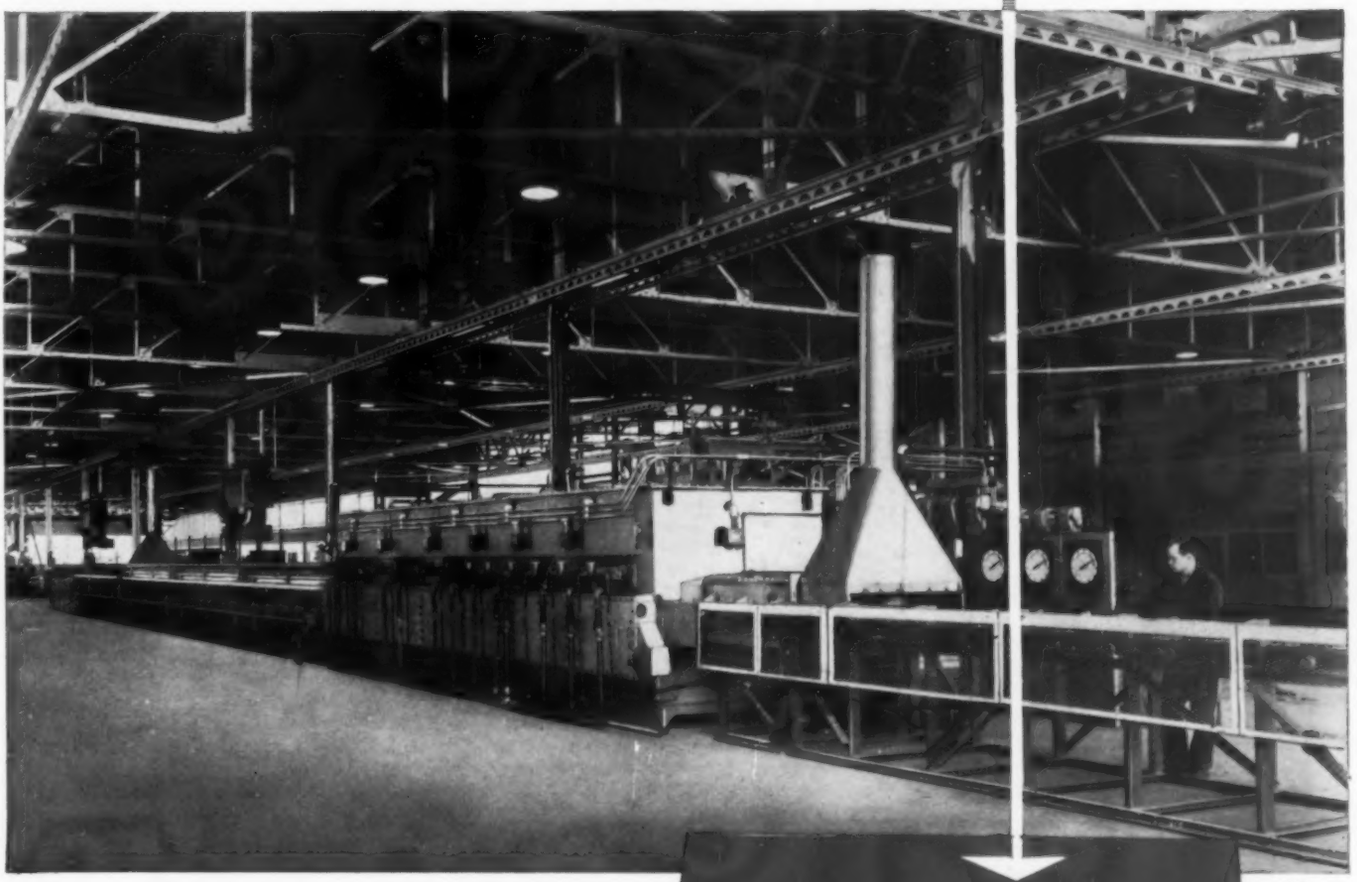
TRADE MARK BRISTOL'S REG U.S. PAT OFFICE

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

DREVER

ROLLER HEARTH *Bright Annealing* FURNACES



12

Shown above:

Controlled Atmosphere Furnace
Radiant Tube, Gas-Fired
Capacity, 3,000# /hour
Alloy Tubing ⅛" O.D. to 2½" O.D.
Overall, 176 ft. long x 7'-6" wide

FOR

CARBON and ALLOY STEEL PARTS, BARS or TUBING

Also Available:

Gas or Electric Furnaces for Stainless Steel Annealing with or without Controlled Atmosphere

Installed at the plant of Sawhill Tubular Products, Inc.

DREVER CO.

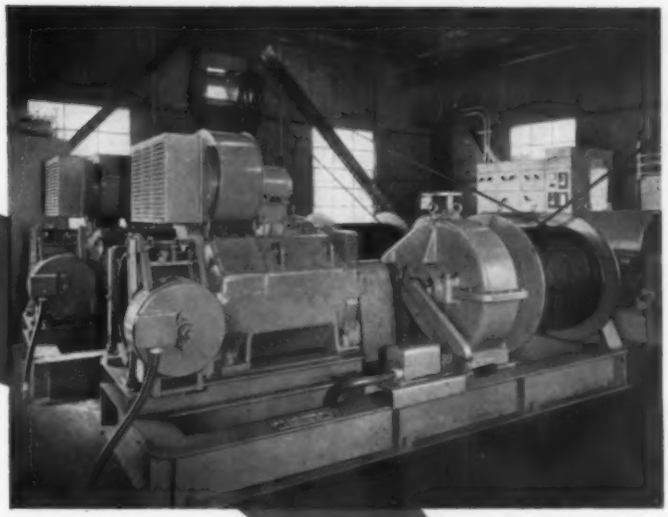
RED LION ROAD & PHILMONT AVE.
BETHAYRES, PA.

Elliott equipment helps feed t

WG-1

An enlarged view of one of the two coal barge unloaders at the Clifty Creek Station shown above. Designed, built, and erected by Heyl & Patterson, Inc., Pittsburgh. It is rated at 1100 tons per hour and uses a 12-ton grab bucket. Elliott motors, generators and control are in the house at top.

d the giants!



Two Elliott 187½-hp Frame 616 protected forced-ventilated hold and close drive mill-type d-c motors drive the drum through gears. They operate at approximately 345 volts and 685 rpm.

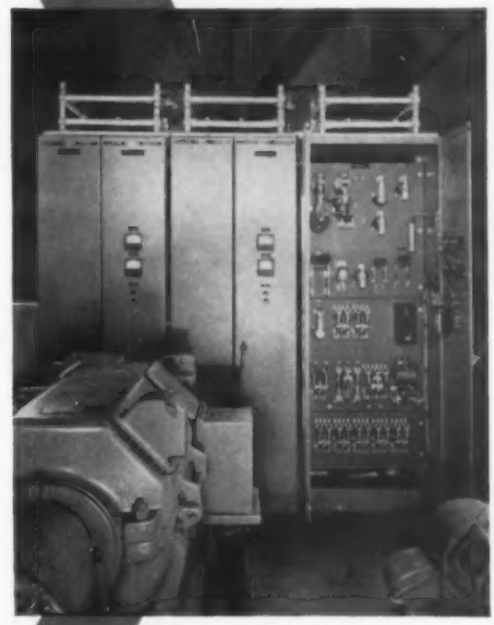
THE TWO LARGEST POWER PLANTS ever built by private enterprise—the Clifty Creek and Kyger Creek stations of the Ohio Valley Electric Corporation—supply power to the U. S. Atomic Energy Commission's uranium diffusion plant near Portsmouth, Ohio. The tremendous coal requirement of these plants is supplied via barge on the Ohio River.

Elliott C-W adjustable-voltage motors, motor-generators and control, are helping to assure high-speed, efficient operation for the coal unloading equipment at these stations. There are two coal barge unloaders at the Clifty Creek Station shown here, and two at the Kyger Creek Station.

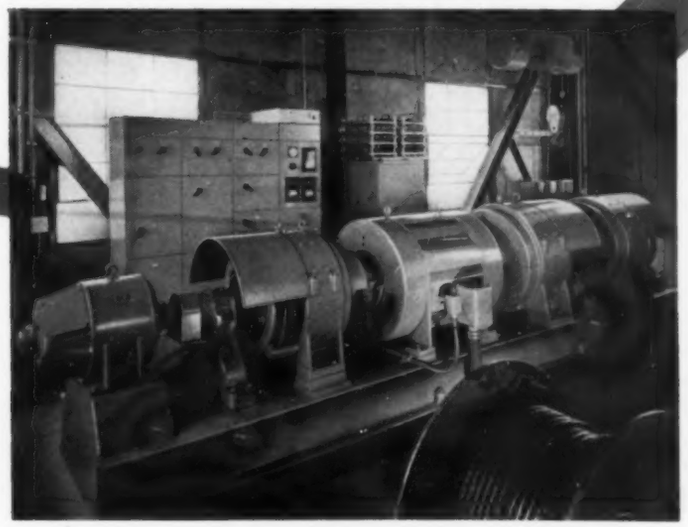
The five-unit motor-generator set provides power for hoist and trolley motors as well as the necessary excitation for the motor fields, brakes, regulators, and control circuits. All driving motors are 600-series, heavy-duty mill motors, and the generators of the m-g set have special characteristics suitable for regulator control and peak capacity of these motors. It pays to check with Elliott for up-to-date, engineered installations like this. For details, write Elliott Company, Crocker-Wheeler Division, Jeannette, Pa.

ELLIOTT Company

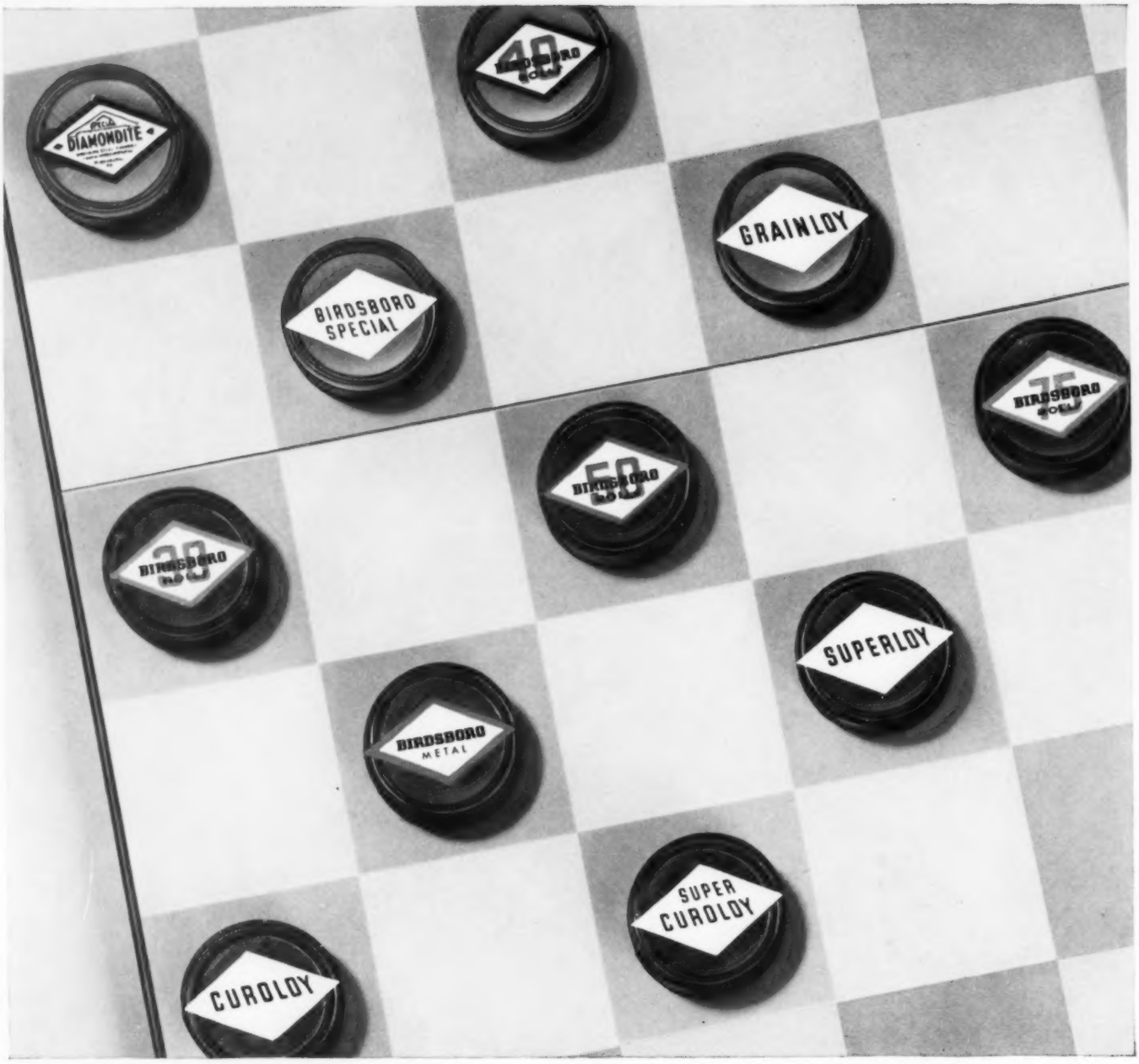
STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS



An Elliott 294-hp, Frame 612, 230-volt protected self-ventilated mill-type d-c trolley motor, which is operated at approximately 317 volts and 710 rpm. Control cabinets in background.



A five-unit, adjustable-voltage, motor-generator set consisting of a 400-hp, 1150-rpm, 2300-volt squirrel-cage induction motor driving two 200-kw, 345-volt d-c generators for the hold and close drives, one 75-kw adjustable voltage auxiliary generator for trolley drive, and a 15-kw, 250-volt d-c constant potential exciter.



Make the right move with

BIRDSBORO ROLLS

Designers and Builders of:

STEEL MILL MACHINERY
HYDRAULIC PRESSES
CRUSHING MACHINERY
SPECIAL MACHINERY
STEEL CASTINGS
Weldments "CAST-WELD" Design
ROLLS: Steel, Alloy Iron, Alloy Steel

● And you can't make a wrong move once you make that choice, because the individualized service that Birdsboro gives is based on more than 50 years' experience. Individually designed, highly specialized Birdsboro Rolls will increase your tonnage, give you greater accuracy and last longer. Let our representative recommend the Birdsboro Roll best suited to give you top performance.

IRON BASE ROLLS: Grainloy, Birdsboro Metal, Curoloy, Superloy, Super Curoloy

STEEL BASE ROLLS: Diamondite, Birdsboro Special, Birdsboro "30", "40", "50", and "75".

R-16-56

BIRDSBORO

BIRDSBORO STEEL FOUNDRY & MACHINE CO., BIRDSBORO, PENNA. Offices in Birdsboro, Pa. and Pittsburgh, Pa.

How to get the most out of

Suspended Refractory CONCRETE CONSTRUCTION

An example of B&W's Modern Suspended Castable Construction

Cross section of castable form showing patented anchor tile and "ice-tong" hanger, which can be attached any place on I-beam.

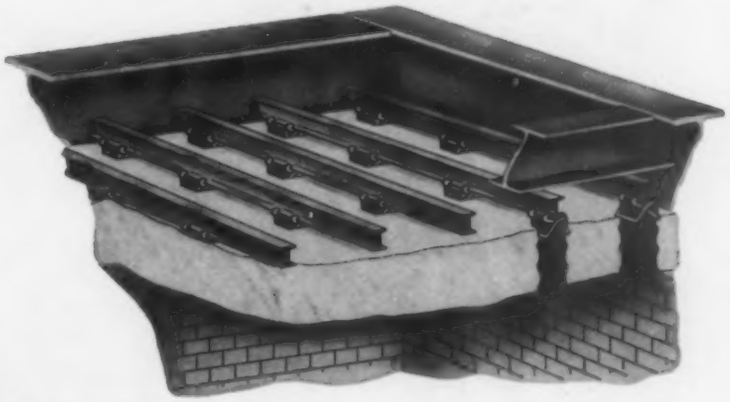
B&W Kaocast may be gunnited, as shown above, or poured into a form.

The big reason behind today's growing use of suspended castable construction is lower installation cost. The replacement of standard brick and special shapes by refractory castables (just as easy to use as structural concrete) is becoming so widespread that every furnace operator should consider it as a possible means of cutting his own installation costs.

Not only can refractory castables be handled easily, but such troublesome jobs as notching I-beams have been eliminated with B&W's patented anchor tile and "ice-tong" hanger. Maintenance patching is quicker, too, because this hanger can be slipped on or off anywhere on the beam.

But the major reason for the general preference of B&W's suspended castable construction is B&W Kaocast—the only refractory concrete for service up to 3000 degrees. Even at lower temperatures, B&W Kaocast results in longer, more economical service because it has a high resistance to spalling and practically no reheat shrinkage.

The step-by-step story shown at the right is an example of how B&W's modern suspended castable construction is used in soaking pit covers. These covers take plenty of abuse because of the rough handling they get, but B&W Kaocast stays on the job.



Cross section of finished B&W Kaocast soaking pit cover, showing anchor tile and "ice-tong" hangers.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

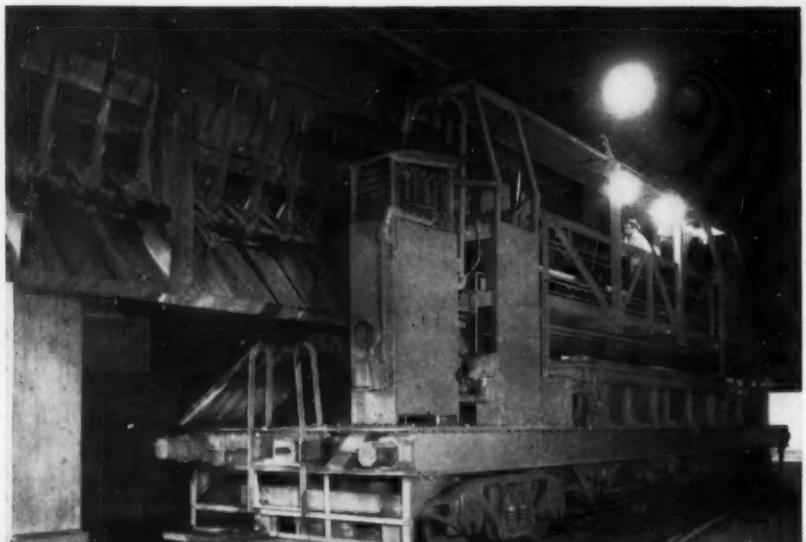
B&W REFRACTORIES PRODUCTS — B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick B&W Refractory Castables, Plastics and Mortars • OTHER B&W PRODUCTS—Stationary & Marine Boilers and Component Equipment . . . Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers . . . Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

HIGH LINE • STOCK HOUSE

Performance

IS ASSURED BY

ATLAS CARS



Atlas cars are ruggedly built to assure the dependability needed to maintain charging cycles. Each is engineered to the specific operating requirements of the plant where it will be used.

Manufacturers of Ore Transfers • Scale Cars
Coal Charging Cars • Coke Quenching Cars
Coal and Metal Mining Locomotives

THE ATLAS CAR & MFG. COMPANY

1100 IVANHOE RD.
CLEVELAND 10, OHIO

Engineers & Manufacturers since 1896

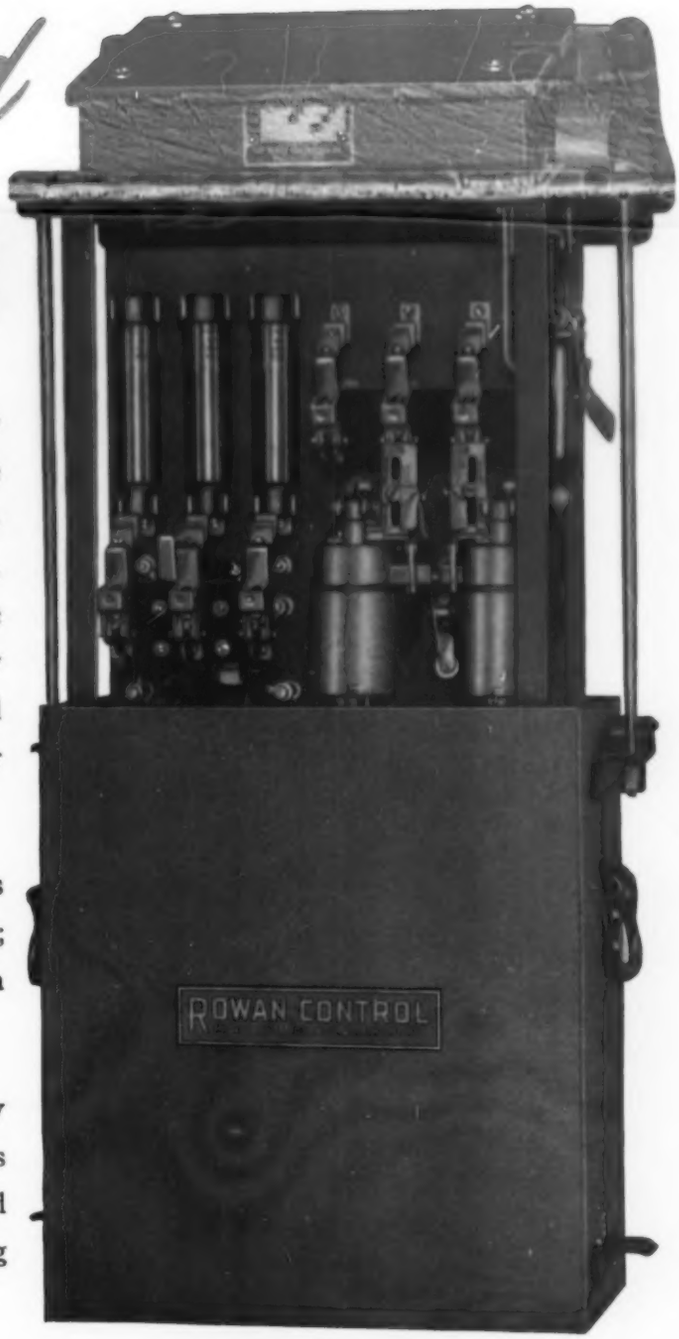
Oil Immersed

LOW VOLTAGE ACROSS-THE-LINE MOTOR STARTERS

Rowan Low Voltage, Across-the-line Motor Starters of the 780 Series are built to meet the requirements of NEMA Type XI and modifications are available for special applications. Their dependable performance under severe atmospheric conditions make them ideally suited for use in industries such as chemical plants, oil refineries, steel, cement and paper mills.

Incorporated in the 780 Series are such features as: easy access for inspection and maintenance; interchangeability of component parts with other starters of the same frame size.

Starters of the 780 Series are available in many combinations due to many variable components such as: safety disconnect switch, overload relays, Rowan AIR-SEAL fuses and wiring seal-off compartment.



Type 780 KBF, Frame 50

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

NEW! 24-PAGE CATALOG ON WATERBURY FARREL SLITTERS

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WATERBURY FARREL FOUNDRY & MACHINE CO.
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Covers extensive line of WF slitting equipment for warehouse and factory use. Sizes range from small hand-operated slitters with 3" diameter cutters to fully automatic slitting lines with 16" diameter cutters.

Gives details on various slitter types as well as payoffs and coil boxes, loaders, straighteners, feed rolls, back rolls, cutters and spacers, stripper fingers, winders and coilers. Includes specifications and cutting capacity chart. Send for your copy.

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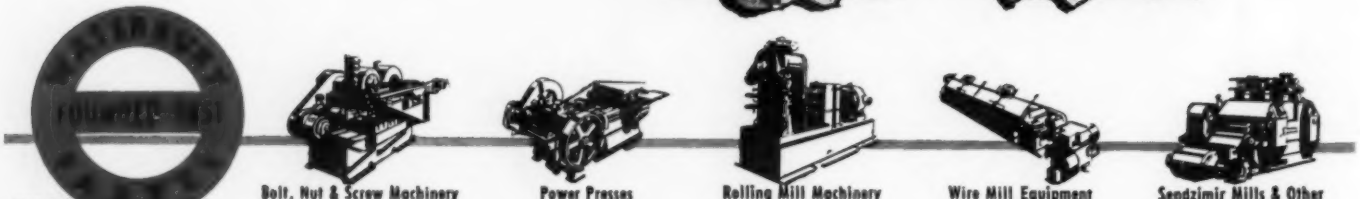

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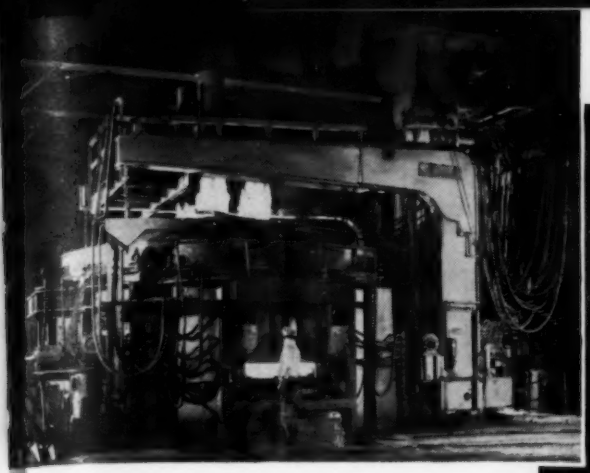
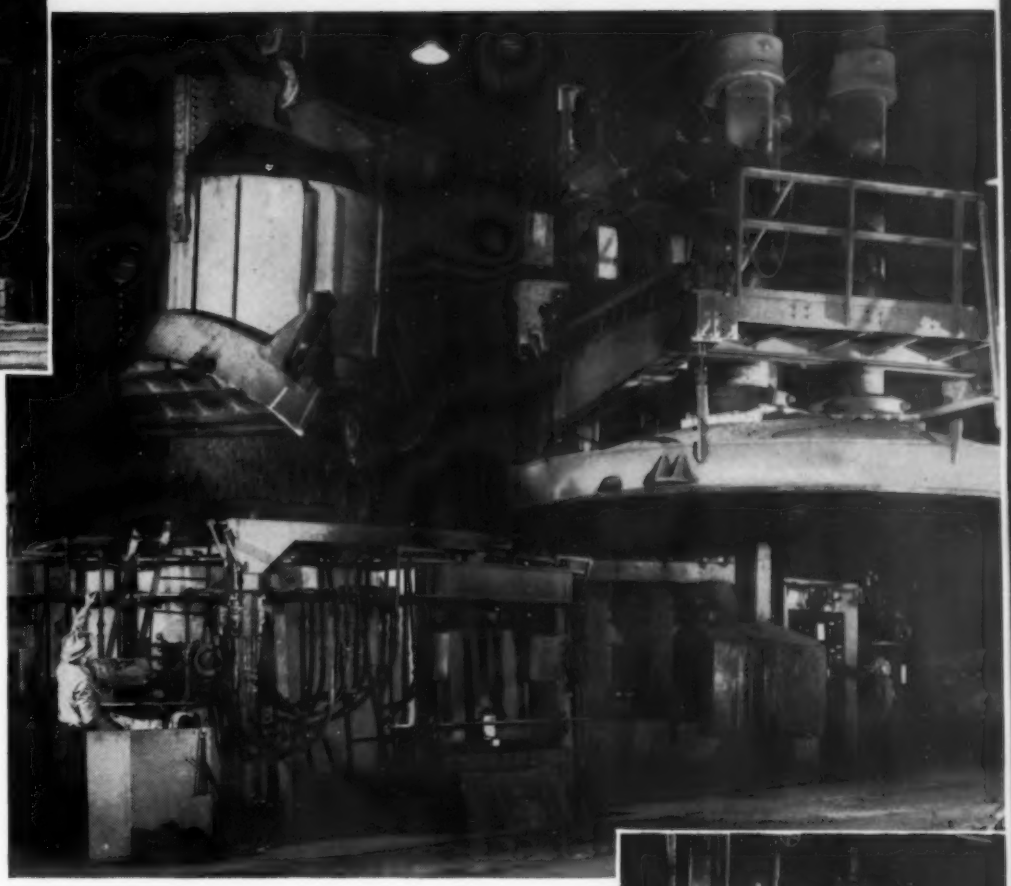
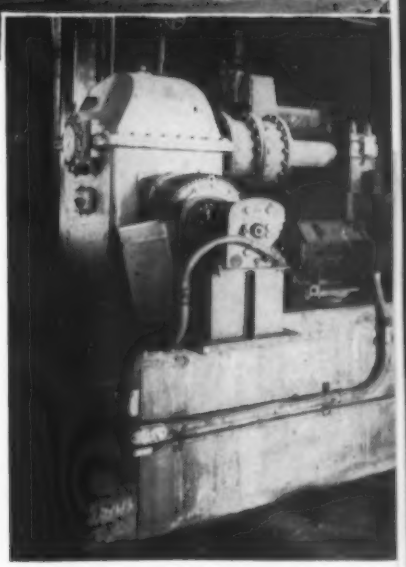




Shown above is a 20′ diameter shell Top-Charge Heroult Furnace. At right, the same furnace is shown with swing-type roof removed for charging. Smaller picture at lower right, shows tilting mechanism for 20′ diameter Heroult.



Heroult Electric Furnaces for faster, high quality steel making - -

To keep pace with modern steel making methods . . . to produce better quality steel faster, and more economically, it will pay you to consider the addition of electric furnaces to your existing facilities.

In the light of the experience of some of the nation's most successful mills, Heroult Electric Furnaces should easily prove a big time and labor saver, *and quality up-grader* for you.

Embodying the latest in mechanical and electrical equipment, these widely used furnaces are noted for their efficient performance, and low operating and maintenance costs.

Available in sizes of shell diameter ranging from 7′0″ up to 24′6″, and with rated charge capacity of from 8000 lbs. up to 400,000 lbs. They are usually equipped with roof-moving mechanism to permit top charging. Both gantry and swing-type roof-moving mechanisms are available. Door-charging furnaces and furnaces of special design, including units equipped with austenitic steel bottoms to permit inductor stirring, can also be supplied.

We welcome an opportunity to help you select and install the Heroult Electric Furnace best suited to your particular requirements.

THIS CATALOG

contains up-to-date information on Heroult Electric Furnaces — types, sizes, capacities, rating, etc. For free copy, write to our Pittsburgh office.

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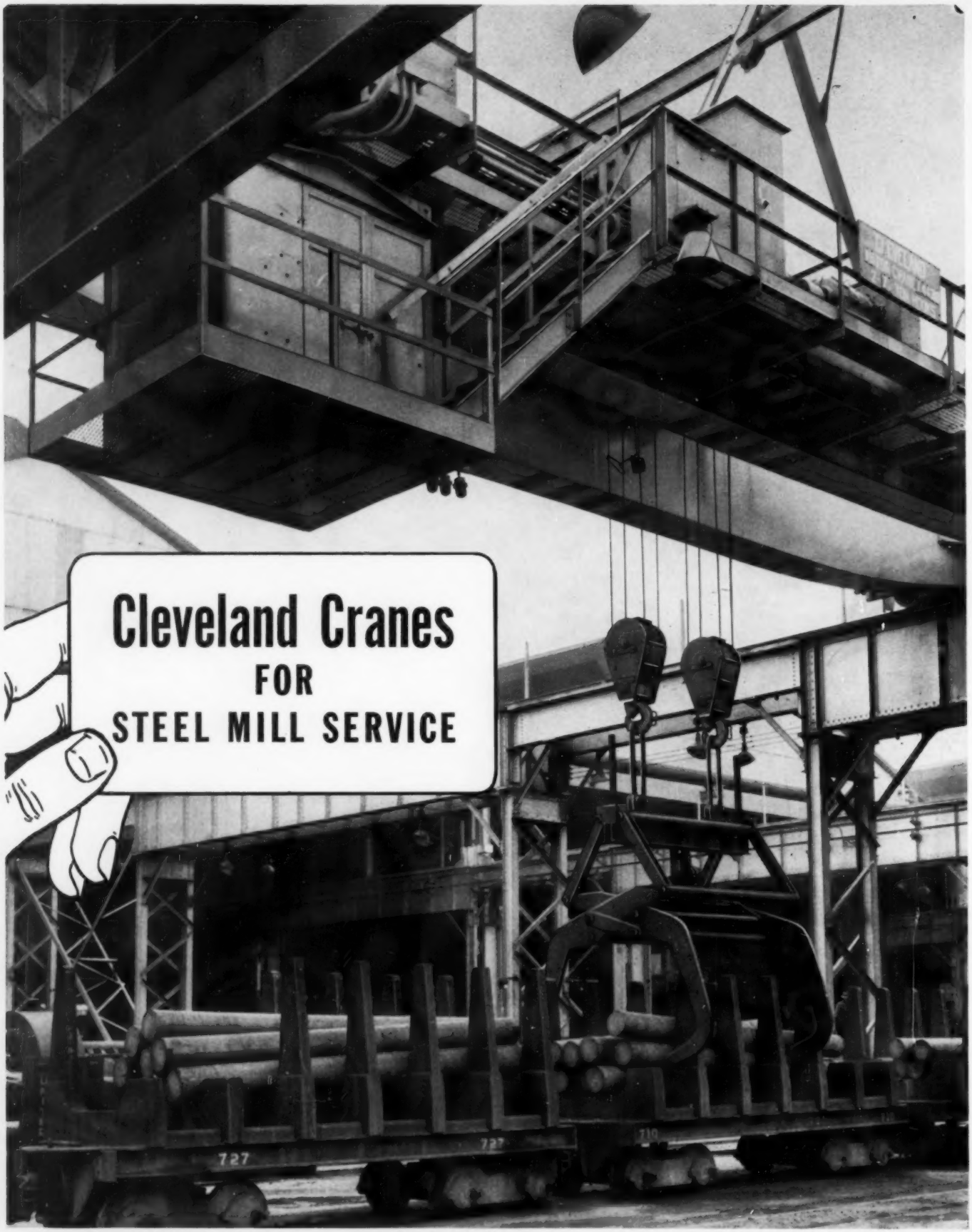
UNITED STATES STEEL CORPORATION, GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

Contracting Offices in New York, Philadelphia, Chicago, San Francisco and other principal cities.

United States Steel Export Company, New York

USS

UNITED STATES STEEL



CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops and Shorts

THE American Iron and Steel Institute reports that the industry will spend $1,200,000,000 in 1956 for new equipment and construction, or 64 per cent more than in 1955. B. F. Fairless, president of the Institute, says that the industry plans to add another 15,000,000 tons of steelmaking capacity in the next three years, so spending in 1957 and 1958 should also exceed $1,000,000,000 per year.

Add about $1,000,000,000 per year for maintenance and you've got a nice cozy little market ahead.

▲

WITHOUT any overall mark-up, steel prices have crept up about one dollar a ton in the past few months. Prices may increase another three dollars a ton by spring. What summer and fall may bring depends largely on wage negotiations which will start in May or June.

David J. McDonald, president of the United Steel Workers, has indicated that union demands will include a lay-off plan similar to that negotiated with can producers. This plan calls for 65 per cent of take-home pay for a maximum of 52 weeks for any one lay-off period.

▲

ACCORDING to the United States Chamber of Commerce, 17 large American corporations now have more stockholders than employes. We hope the politicians will keep this fact in mind.

▲

SALES, production and earnings figures reported for 1955 by the steel industry show new record levels. In general, sales are up 25-30 per cent and earnings about 65 per cent above 1954 figures.

▲

THE machine tool industry is likely to enjoy one of the best years in its history in 1956, according to the Value Line Investment Survey. Virtual capacity operations for most of the year are indicated, due to general business activity, government buying, and newly developed models.

The same survey service sees price of steel stocks too high because the capital expenditure plans of the industry will restrict the amount of cash available for dividends to lower levels than would be implied by earnings alone.

Eugene G. Grace, chairman of Bethlehem Steel Co., is more optimistic about future business than some of the other steelmasters. He looks for good steel business throughout the entire year, whereas most of the steelmakers predict capacity business only through the first six months.

▲

STEEL making countries of the world produced a record total of about 294,000,000 net tons of raw steel in 1955, according to the American Iron and Steel Institute. This is 20 per cent above 1954 output and 39,000,000 tons above the record set in 1953.

Of the total, free world countries turned out about 224,000,000 tons, or 76 per cent of the total. Iron Curtain countries produced about 70,000,000 tons, of which 49,500,000 tons was made in Russia.

▲

THIS year marks the 100th anniversary of the Bessemer and Mushet patents, which ushered in the age of steel.

▲

N. P. HAYES, vice president of the American Institute of Steel Construction, says that the steel mills are promising greatly increased rolling of shapes and steel fabricators expect to increase shipments in 1956 by 12 per cent.

▲

SPEAKING before the general meeting of the American Institute of Electrical Engineers, Roger M. Blough, chairman of the board of United States Steel Corp., listed three ways in which America is acting to produce the engineers needed for our national growth:

The law of supply and demand is operating to increase the reward of engineering careers.

Large companies are moving to insure fullest and most satisfying use of engineering and scientific personnel.

The appeal of the honor, prestige and sense of service in engineering and scientific careers will attract young people into these fields.

▲

THE 1955 payroll of the iron and steel industry is estimated at a record $3,597,556,000. The industry's employment total is estimated at 657,600, with, wage earners working an average of 39.2 hours per week.

▲

A NEW monthly record for ingot production was set in January, with a tonnage of 10,811,000.

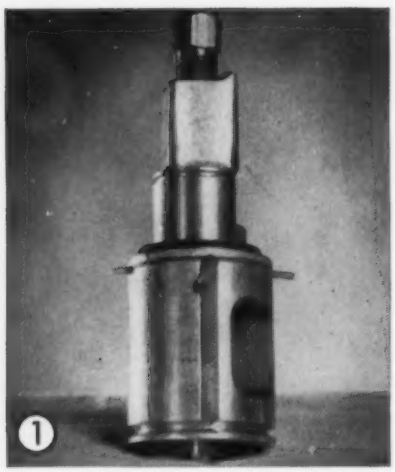
▲

THE 50,000,000,000th can for packaging beer was made last month. About 8,000,000,000 cans (one out of every five metal containers made in the United States) per year are now being used for packaging beer.

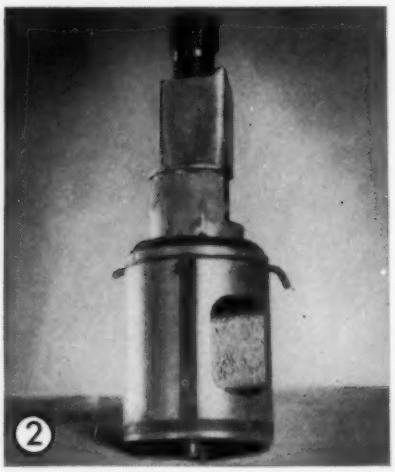
▲

CLEAN, straight cuts can be made in concrete with a standard industrial powder-cutting blowpipe.

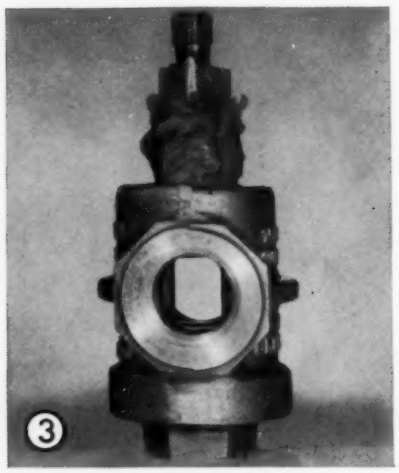
*SEE HOW *Controlled*
PRESSURIZED LUBRICATION
GUARANTEES LOWEST COST SERVICE FROM
HOMESTEAD *lubricated* PLUG VALVES



This plug was removed from a Homestead Valve just after starting lubrication, and before all sealing areas were filled with lubricant. Note that pressurized lubricant continues to extrude through feeder holes. Momentary downward movement of plug at start of each lubrication, gives assurance that plug is always free to turn.

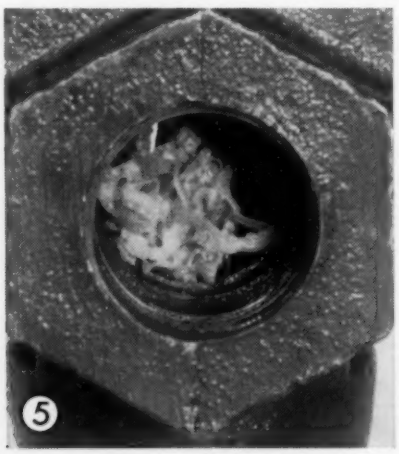


The plug was again withdrawn from the valve body just after a ring of lubricant around the stem indicated that the lubricant system was full. Note that all lubricant grooves are filled. The entire plug surface is coated with lubricant. Lubricant is well packed in the stem sealing area above the plug.



Now valve has been purposely over-lubricated as indicated by excess lubricant around stem. Note that with *controlled* pressurized lubrication there is no extrusion or seepage of lubricant into valve port opening. This means no waste, no contamination of line fluids, no clogging of low pressure lines with lubricant, or fouling of meters, orifices, etc.

Also, in the Homestead Valve with *controlled* lubrication, you will note that even though the valve has been over-lubricated, lubricant comes only to the bottom edge of the plug, and is not wasted by discharging in quantity into the bottom chamber.



Now, see for yourself the risk involved when a valve which does *not* have Homestead's *controlled* Pressurized Lubrication, is over-lubricated. Note lubricant has been forced into the port opening. It can contaminate line fluids, foul meters or orifices, or even block low pressure lines!

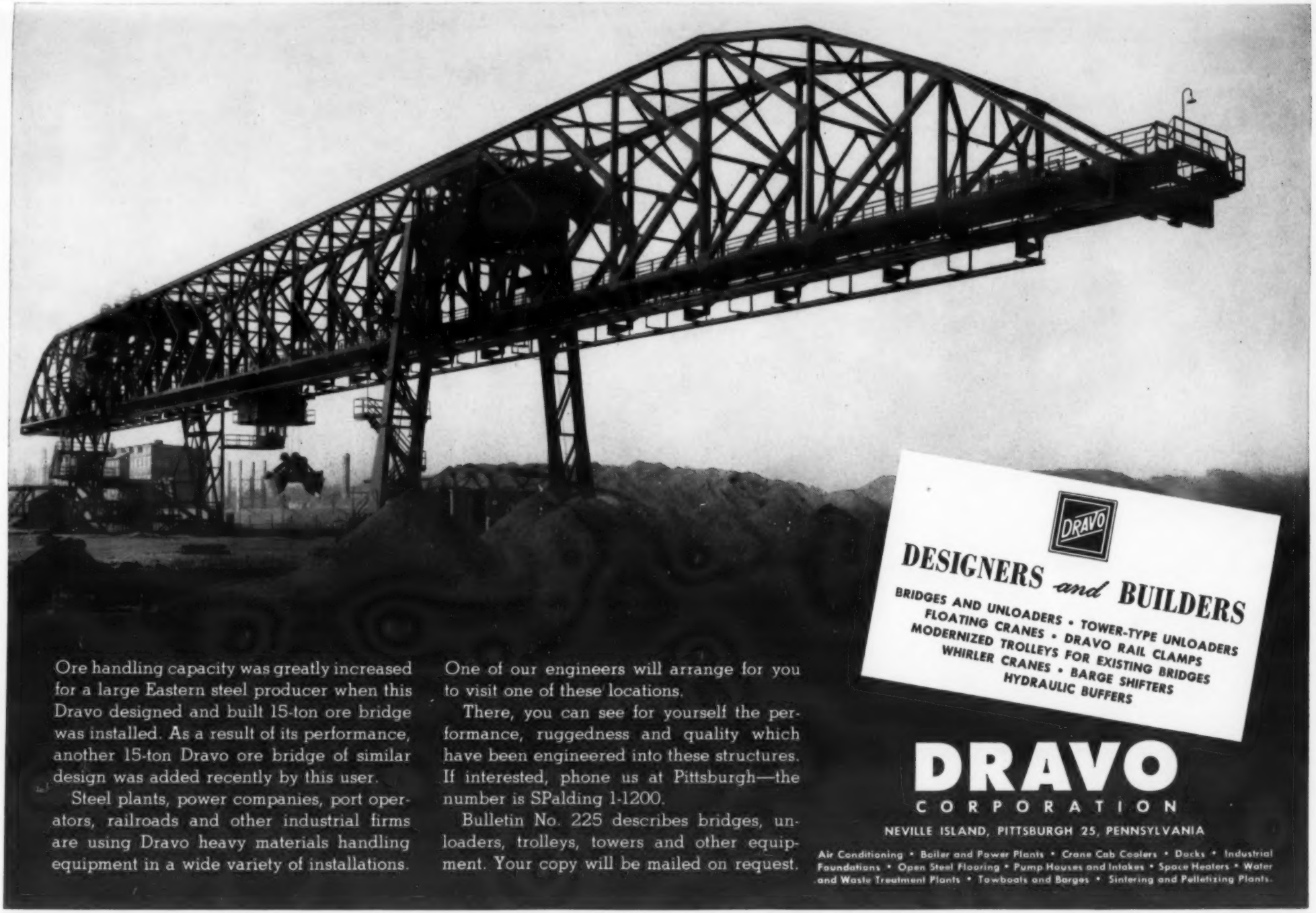
* Unretouched photos.

These are but a few of the many advantages of Homestead's controlled pressurized lubrication that guarantee lowest cost valve service.

Reference Book 39-5 has the full story—twenty-eight pages of engineering facts, sizes, types, dimensions, etc. Ask for your copy today. There is no obligation.

HOMESTEAD LUBRICATED PLUG VALVE (Pat. Pend.)

HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. Box 21 Coraopolis, Pa.



Ore handling capacity was greatly increased for a large Eastern steel producer when this Dravo designed and built 15-ton ore bridge was installed. As a result of its performance, another 15-ton Dravo ore bridge of similar design was added recently by this user.

Steel plants, power companies, port operators, railroads and other industrial firms are using Dravo heavy materials handling equipment in a wide variety of installations. One of our engineers will arrange for you to visit one of these locations.

There, you can see for yourself the performance, ruggedness and quality which have been engineered into these structures. If interested, phone us at Pittsburgh—the number is SPalding 1-1200.

Bulletin No. 225 describes bridges, unloaders, trolleys, towers and other equipment. Your copy will be mailed on request.

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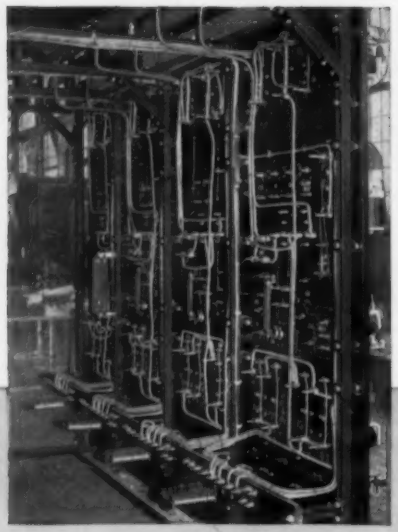


Back of panel shows accessibility of terminal blocks and neat grouping of wiring.

ALLIS-CHALMERS

CONTROL

Modern

Constant Potential Panels for Top Efficiency and Low-Cost Operation

Steel mill control is an Allis-Chalmers specialty. That's why many mills and their consultants are turning to Allis-Chalmers for engineering help and the latest in control equipment . . . equipment like this constant potential panel for dc auxiliary drives. Operating under the roughest conditions, this unit is providing smooth, precision performance . . . affording maximum production and quality with a minimum of outage time and maintenance.

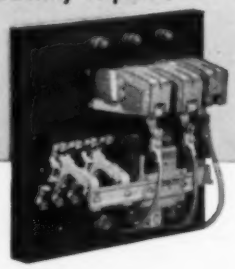
Constant potential and variable voltage systems, magnetic amplifiers, rotating, electronic and mechanical regulators, liquid rheostat — all engineered, built and applied by Allis-Chalmers — are building greater profits in modern mills. When you modernize to meet the double challenge of a growing market and heavy competition, take advantage of Allis-Chalmers experience. Call your A-C representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4588

Type 260 Contactor

Quick-quenching arc-centering blowout solves problem of contact burning by sharply curtailing arcing time.

NEW heavy-duty Type 522 contactors and Type 521 relays feature exceptional interchangeability of parts.



Type 522 Contactor

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

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Iron AND Steel ENGINEER

FEBRUARY, 1956 VOLUME XXXIII NUMBER II

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PLASTIC BINDING U. S. PATENT NO. 1970285 LICENSE NO. 120

Atlantic Steel adds their second 75-ton Lectromelt* Furnace

SOUTHERN steel production received another boost early this winter when Atlantic Steel Company's new electric furnace began operation. This 75-ton Lectromelt Furnace is the second such unit to be installed by this Atlanta, Georgia, firm during the past three years.

125,000 tons of steel per year are added by this new furnace, increasing their ingot capacity by 30%.

Atlantic Steel laid out this plant, from scrap storage yard to pouring pit, around these Lectromelt Furnaces. This fact, plus the economies of time and labor contributed by Lectromelt's top-charging and ability to pour on the power, account for the higher production and constant increase in quality being achieved here.

Pittsburgh Lectromelt Furnace Corporation, 310 32nd Street, Pittsburgh 30, Pennsylvania.

Manufactured in...GERMANY: Friedrich Kocks GMBH, Dusseldorf...ENGLAND: Birlec, Ltd., Birmingham ...FRANCE: Stein et Roubaix, Paris...BELGIUM: S. A. Belge Stein et Roubaix, Bressoux-Liege...SPAIN: General Electrica Espanola, Bilbao...ITALY: Forni Stein, Genoa...JAPAN: Daido Steel Co., Ltd., Nagoya

*REG. T. M. U. S. PAT. OFF

MOORE RAPID

WHEN YOU MELT... *Lectromelt*

Report on Standardization of additional AISE Mill Motor Frames

By M. B. ANTRIM
Chairman
AISE Mill Motor Standardization Committee

. . . . results of the AISE Mill Motor Committee's work on developing a larger mill motor frame required by the steel industry are given in this paper . . . . comments and criticisms are invited from the industry . . . . AISE members are requested to fill in the questionnaire at the end of this article and send it in to AISE headquarters . . . .

▲ APPROXIMATELY two years ago, the increasing demand for larger horsepowers and torques on mill auxiliary and crane drives prompted the Standardization Committee of the Association of Iron and Steel Engineers to reactivate the Mill Motor Standardization Committee in order to determine the necessity and practicability of standardizing larger mill motors than the present frame 618 rated 200 hp, totally enclosed, 1 hour, 75 degree C rise. Accordingly, a committee representative of both the steel industry and also the manufacturers of this type of equipment were selected. This committee consists of the following personnel representing the steel industry:

M. B. Antrim, assistant manager, maintenance and construction, Lukens Steel Co. (Chairman).

H. H. Angel, Construction Engineering Department, Bethlehem Steel Co.

R. J. Beeswy, electrical superintendent, Inland Steel Co.

Roland Hess, senior electrical engineer, Armco Steel Corp.

George A. Kaufman, chief electrical engineer, Jones and Laughlin Steel Corp.

R. L. Livingston, chief electrical engineer, United States Steel Corp.

D. C. McCrady, electrical superintendent, The Steel Co. of Canada, Ltd.

I. N. Tull, electrical superintendent, Republic Steel Corp.

In addition, the following representatives of the equipment manufacturers are on this committee:

S. K. Hostetter, Jr., general manager, Crocker-Wheeler Division, Elliott Co.

George R. Williamson, chief d-c engineer, Crocker-Wheeler Division, Elliott Co.

C. R. Steen, d-c section engineer, Elliott Co.

Willard G. Cook, industry engineering manager, Elliott Co.

Frank W. Cramer, consulting engineer, Elliott Co.

C. B. Hathaway, manager d-c motor engineering, Westinghouse Electric Corp.

E. H. Myers, section manager, Transformer and Generator Division, Westinghouse Electric Corp.

M. W. Kitzmiller, manager, d-c armored motor engineering, General Electric Co.

F. C. Kreitler, design engineer, armored motor engineering, General Electric Co.

I. E. Masden, research and standards engineer, Association of Iron and Steel Engineers.

The initial meeting of this committee developed the expediency of further mill motor line standardization in view of the increasing demand of equipment of this type for use on such applications as ore bridges, ladle cranes, shears, reel drives, levelling rolls, skip hoists, car dumpers and flanging machines. The committee therefore decided in the light of the facts presented that such action should be taken.

The original line of mill motors has provided the steel industry through the years with motors whose versatility of application is without exception. Naturally it was felt that all of the advantageous factors representing this versatility such as low rotational inertia to provide quick acceleration and deceleration, durability

AISE MOTOR FRAME	TOTALLY ENCLOSED ONE HOUR, 75°C. RISE				PROTECTED SELF-VENTILATED CONTINUOUS 75°C. RISE				PROTECTED SELF-VENTILATED ONE HOUR, 75°C. RISE				TOTALLY ENCLOSED 60°75°C. RISE & PROTECTED SELF-VENTILATED CONT. 75°C. RISE TORQUE IN POUND FEET								
	HP	RPM			HP	RPM			HP	RPM			RATED 75°C. RISE			MAX. STARTING*			MAX. RUNNING**		
		SERIES	COMPOUND	SHUNT		SERIES	COMPOUND	SHUNT		SERIES	COMPOUND	SHUNT	SERIES	COMPOUND	SHUNT	SERIES	COMPOUND	SHUNT	SERIES	COMPOUND	SHUNT
230 VOLTS																					
620	275	370	390	390	275	370	390	390	350	350	370	390	3900	3700	3700	19500	16650	13320	15600	12950	11100
622	375	340	360	360	375	340	360	360	475	320	340	360	5790	5460	5460	29000	24600	19660	23200	19110	16380
624	500	320	340	340	500	320	340	340	625	300	320	340	8210	7720	7720	41100	34740	27790	32800	27020	23160

ADJUSTABLE SPEED DIRECT CURRENT MILL MOTORS	
SHUNT OR STABILIZED SHUNT WOUND	
AISE MOTOR FRAME	ONE HOUR 75°C. ENCLOSED CONT. 75°C. SELF VENTILATED
	HP / RPM
230 VOLTS	
620	275 / 390/975
622	375 / 360/1080
624	500 / 340/1020

* THE VALUES FOR MAXIMUM STARTING TORQUE ARE BASED ON THE FOLLOWING APPROXIMATE RATIOS TO THE CORRESPONDING 1 HOUR TOTALLY ENCLOSED TORQUE RATINGS:

RATIOS

VOLTS	SERIES	COMPOUND	SHUNT
230	5	4.5	3.6

** THE VALUES FOR MAXIMUM RUNNING TORQUE ARE BASED ON THE FOLLOWING APPROXIMATE RATIOS TO THE CORRESPONDING 1 HOUR TOTALLY ENCLOSED TORQUE RATINGS:

RATIOS

VOLTS	SERIES	COMPOUND	SHUNT
230	4	3.5	3

ENCLOSED FORCE-VENTILATED DIRECT CURRENT MILL MOTORS SERIES, COMPOUND, SHUNT AND STABILIZED SHUNT WOUND.		
230 VOLTS		
THE CONTINUOUS, 75°C. RISE RATINGS OF ENCLOSED FORCE-VENTILATED MOTORS ARE EQUAL TO THE 1 HOUR 75°C. RISE TOTALLY ENCLOSED RATINGS WHEN THE REQUIRED VOLUME OF VENTILATING AIR FOR SUCH RATINGS IS SUPPLIED TO THE MOTORS		
AISE MOTOR FRAME	REQUIRED CFM AIR	STATIC PRESSURE INCHES OF WATER AT MOTOR INLET
620	2000	1 3/4
622	2700	1 3/4
624	3500	1 3/4

Figure 1 — Ratings, speed and torques are given for the proposed standard 620, 622 and 624 AISE mill motor frames.

both in poor working conditions and also under undesirable loading as well as other benefits of standardization on availability should be accepted as mandatory conditions to apply to any new standardized motors. The prime reason for standardization, interchangeability, was also considered in the light that the new motors might possibly be made to at least fit the space where previous non-standardized motors of equivalent characteristics may be at present applied.

In fact, it was desired that additional conveniences such as greater accessibility of brush holders, standardization of connection locations, ventilating air openings, type of shaft nut and lockwasher, as well as improved safety through screening air vents should be worked into the design of these larger motors if possible. At the same time, standardization is limited primarily to the interchangeability features to give the manufacturer as great a field of design choice as possible, thereby not raising any bars to improvements and progress.

In subsequent meetings of the committee, three motors were standardized. Their horsepowers and speeds and rotational inertias follow a logical extension of the present mill motor line. However, the large size of these motors causes certain limitations to appear for reasons of economic practicability which limitations are not present in the existing mill motors. These limitations are four in number and are:

1. Standardized motor frames are split but are not hinged.
2. Standardized motors are applicable for coupled service only.
3. Standardized motors are not available with back axles.
4. Standardized motors will not be furnished at 550 volts. However, they are equivalent in insulation level to the present mill motor line and can be utilized on variable voltage applications.

The three proposed standardized ratings are as follows:

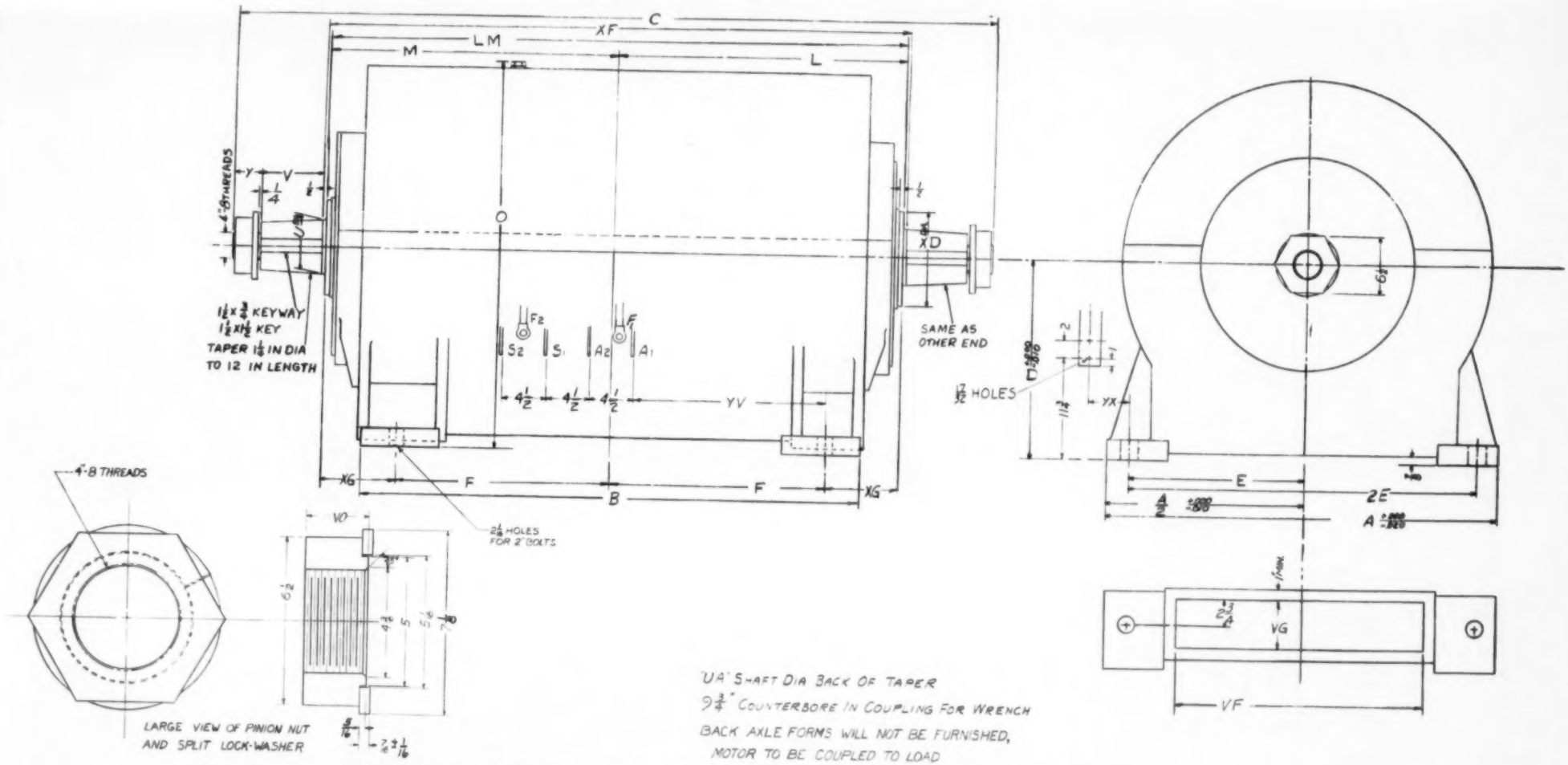
Frame	HP	Speed rpm shunt and compound	Totally enclosed
620	275	390	1 hr 75 C rise
622	375	360	1 hr 75 C rise
624	500	340	1 hr 75 C rise

You will note these horsepowers represent logical extension intervals of 75, 100 and 125 hp above the present 200-hp, frame 618 standard mill motor. Series-wound, speeds for the proposed motors on a one hour 75 C rise, totally enclosed basis are respectively 370, 340 and 320 rpm.

At the present time, standardization of the three proposed motors has been completed and the committee has accepted this proposed standard. Details are given in Figures 1 and 2.

It remains, however, for the membership of the AISE to now either vote their approval or send us their constructive criticism so that the proposed motors may eventually be included in the Association of Iron and Steel Engineers Mill Motor Standard No. 1. In this connection, upon the approval of the Association's Board of Directors, a tentative Standard No. 1A covering the three proposed motors will be issued to the membership. Their comments concerning this tentative standard will be most valuable, since changes can be made in the tentative standard, but once this material is included in the mill motor standard, any changes will be most difficult due to their possible far reaching effects. We also respectfully point out that since these motors are quite large, it is possible that certain changes may produce different economics than similar changes to smaller motors. At any rate, help in resolving the tentative standard will be greatly appreciated. At the present time, some of the manufacturers are designing and building some of these motors based on the tentative standard.

Speaking for the Mill Motor Committee, we certainly hope that the steel industry will welcome these new motors with an enthusiasm equal to that which



FRAME	HP	SHUNT MOTOR RPM	SHUNT MOTOR TORQUE	200 SERIES BRG BORE	A	B	C	D	E	F	L	M	LM	O	U	UA	V	XD	XF	XG	Y	YV	YX	VF	VG	VO
620	275	390	3700	150MM	41½	52	78	20⅞	18	22	30	30	60	42	5⅞	5⅞	6½	10	61	8	2	18½	4¼	20	5¾	1 3/16
622	375	360	5460	160MM	45½	62	86¼	23	20	25¾	33	33	66	46½	6¼	6¼	7	11	67	7¼	2⅝	22	4¾	28½	6	2 3/16
624	500	340	7720	180MM	47½	68	96¼	24	21	28	36	36	72	48½	7	7	9	12	73	8	2⅝	24	5¾	30	7½	2 3/16

Figure 2 — Standardized dimensions for the proposed 620, 622 and 624 AISE mill motor frames are given in this diagram.

helped us get this job done, and speaking for myself, I am sure that if the cooperation in getting comments on the tentative standard in our hands is just a fraction of the cooperation this committee gave to me, assuredly our problems will then be over.

DISCUSSION

PRESENTED BY

CHARLES R. STEEN, Chief D-C Engineer, Crocker-Wheeler Div., Elliott Co., Inc., Jeannette, Pa.

E. H. MYERS, Manager, Standard Machine Section, Transportation and Generator Engineering, Westinghouse Electric Corp., East Pittsburgh, Pa.

Member: We realize that the need for three larger motor sizes has been apparent for some time, especially in the steel industry, especially since we have gone to greater production. We would like to say that it behooves the manufacturer to incorporate in his individual motor the items which he feels would be best suited to the industry.

Since after the unit is placed in service, it will require maintenance and we hope that the manufacturer will remember and consider this, because standardization of brush motors and brush windings and field coils and so forth, are very essential for this. I also have one comment on the application of the equalizer to the armature winding. We have had numerous difficulties with equalizers. There are three places they can be placed in the armature, one perhaps is at the end of the commutator with which we have had considerable difficulty, especially, due to poor commutation. Another spot is the back end of the armature coil which of course, is quite agreeable. It is very accessible, but due to space limitations, sometimes it is impossible to incorporate them on the back end of the coil. So, we feel from the experience we have had that the equalizer in back of the commutator would be very satisfactory.

Charles R. Steen: I should like to mention several factors briefly, pertinent to the design of these motors. Prospective users of the new motors naturally will have great interest in maintaining the high degree of dependability that has been established by mill motors over more than a 50-year period since our company brought out the first mill motor in 1904.

Up through the intervening years, mill motors have gained a well-earned reputation for being able to take it in severe steel mill service. You can be assured that the 620, 622 and 624 mill motors will be no exception to this rule.

The new motors will follow the same high standards set for the 600 series of mill motors with the incorporation of many up-to-date improvements in design and in manufacture. They will have the same rugged construction with large overload capacity to provide high dependability without sacrificing low maintenance.

As Mr. Antrim pointed out, the new motors will retain the split frame feature to facilitate maintenance. However, our new frames will be fabricated rather than cast. The reason for this is that the larger sizes are more suitable for fabrication where:

1. Frame sections are extremely heavy with the equivalent ruggedness of the cast frame.
2. The round frame with its machined bore provides controlled field coil space which becomes more of an advantage with the larger frames especially as the number of poles increase.
3. Fabricated frames are more accurate, both dimensionally and magnetically, thereby improving manufacture and quality of the finished product.

As with previous mill motors, the armatures will have roller bearings entirely enclosed in bearing cartridges, thus permitting an armature complete with its bearings to be replaced without exposing the bearings to contamination.

You have heard that the 620 to 624 frames are to be applied only for coupled drives. The reason for this is that it is considered impractical to use direct gear drives for these larger horsepowers. That this is a sound policy has been upheld by the fact that to our knowledge only one 200-hp, type 618 mill motor has been furnished with a back axle and this motor was an exception, one which we supplied to revamp an existing mill drive. For new applications, these motors will undoubtedly be coupled to the more efficient self-contained gear units.

A few of the other features that are incorporated in the new designs are:

1. Use of silicone bonded mica materials and silicone bonded glass conductor insulation for long life, even though subjected to excessive temperatures from severe overloads.
2. There is also improvement in the accessibility of brushholders through larger openings.
3. There have been further improvements in commutation and commutator construction.
4. As Mr. Antrim stated, special attention has been paid to designing for low inertia of armatures to meet the rapid acceleration time of approximately 0.3 sec as established for the 600 series mill motors. To accomplish this acceleration, it was necessary to keep the motor speeds low, as can be seen on the new standard rating sheet, since, for a given horsepower rating, the accelerating time of the armature increases very nearly with the rated speed.

Our type 620 motor is a four-pole machine without compensating or pole face windings. The 275-hp rating does not require a compensating winding, and we believe that its omission is highly desirable, especially for relatively inaccessible steel mill applications, for these following reasons: first, simplicity of repair of the motor, second, fewer items involving maintenance, and third, the ease of opening the split frame with far fewer connections to break.

The 622 and 624 frames have six main poles as these machines have become too large for efficient four-pole designs. These motors will by necessity have compensating windings in order to maintain the high commutation standards of the 600 line, and also to provide good speed regulation for field weakening motors.

Finally, it is of interest to know that the new motors will be available with all ratings and enclosures now being provided for other 600 series mill motors. The most common ratings with which you are familiar are:

1. One hour totally enclosed.
2. Continuous protected self-ventilated.
3. Continuous enclosed forced-ventilated.
4. Continuous protected forced-ventilated.

Forced ventilation can be provided either from a separate duct system or by a motor driven blower mounted on the motor frame.

For ventilation from an external source, note that the location and size of the air inlet opening has been standardized below the frame at the end opposite the drive end.

E. H. Myers: Mr. Antrim and Mr. Steen have covered the design details very well but it might be well to point out that in going to the larger sizes of motors, we gain some space advantages that the small ratings do not enjoy. Because of this, we were able to give more accessibility and greater ease in maintenance than in the past.

It was agreed that the advantages of the compensating windings on the two larger sizes would far outweigh the disadvantages and added difficulties of dismantling. Recognizing this problem, the manufacturers have provided means of disconnecting the leads of these windings with a minimum of effort.

Our chairman wisely permitted the companies to make the internal designs of these ratings as they deemed best. By acting as individuals, each company could incorporate those features that they felt offered the most to the customer. This policy always results in maximum progress.

The question of armature cross connections was raised recently. A complete discussion of the merits of various types would take considerable time. Briefly, however, there are four different places these connections can be placed. The conventional location on medium and large machines is at the rear of the rotors below the rear coil extensions. This location offers good accessibility, but other locations offer design advantages on machines with rapid acceleration and deceleration where special precautions must be taken to provide mountings and flexibility to prevent fatigue failures.

The next step would be to move the cross connections closer to the commutator and locate them behind the commutator necks. This type would have the advantage of locating the connections very close to the commutator bars that we are trying to protect from circulating currents. Unfortunately, any maintenance on such connections is very difficult and requires the armature coils to be disconnected and raised before the cross connections can be reached.

The next step would be to use "involute" necks with each commutator bar connected to two coils, two pole pitches apart by means of special necks with involute bends. This cross connects every single coil. However, this type requires so much copper for the very long curved commutator necks that it is not feasible for small machines. Also, the inertia of the copper mass makes it rather unsuitable for machines with rapid acceleration and deceleration.

The fourth type is located on the commutator front V-ring and the connections are made directly to the ends of the commutator bars. This is an excellent location for protecting the bars from circulating currents it is also good mechanically. The connections can be banded securely down to the front V-ring which makes it good for machines subjected to rapid acceleration and deceleration. It can be easily maintained due to its excellent accessibility. Formerly this type had a disadvantage in the problem of soldering the connections into slots at the ends of the bars because of the natural tendency for solder to flow back between the commutator bars and the mica Vee. Methods have been improved, however, and this problem has been overcome by leaving a copper barrier between the connector and the bottom of the bar.

We hope the question of armature cross connections has not been overly emphasized, because little or no cross connection trouble is expected on the new size, particularly because improved accessibility should eliminate any previous brush sticking problems.

Our committee believes you will find that the new machines have been designed to best suit your needs and to carry on the good record that the present line of AISE mill motors has established.

I do_____
I do not____ approve of addition to mill motor standard outlined in this article.

I believe committee should consider the following criticisms or comments before finally approving the article._____

_____

_____

_____

Signature_____

Send to:
Association of Iron and Steel Engineers
1010 Empire Building
Pittsburgh 22, Pa.

Company_____

Address_____

Recent Developments—Sintering and Pelletizing

By EDWIN N. HOWER
Manager
and
JOHN A. ANTHES
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Dravo Corp.
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. . . . recent demands for upgrading ores and for obtaining more production from blast furnaces are being met through increased use of sinter and pellets . . . . improvements in these two processes and a better understanding of them are giving better sinter and better pellets and more economical operations . . . . each particular ore has its own solution and no general conclusions can be established . . . . the methods are seldom competitive but rather supplementary, and pelletizing's particular field lies with the finer ores and concentrates . . . .

▲ THE development of sintering as a practical means of agglomerating fine grained ores occurred at the beginning of this century. The engineering work in this country and in Europe soon produced a commercially practical sintering process which was installed in many iron works on both sides of the Atlantic Ocean. Improvements in the process took place hand in hand in Germany and America, many being the result of joint efforts, until communication was interrupted by World War I. The close association between the sintering firms in these two countries was never resumed after the war and development work on the two continents gradually diverged and followed different patterns. In Europe the scarcity of iron ore suitable for direct charging to furnaces meant that sintering became an important production tool; thus attention has been focused there on improvements in methods and equipment for many years. In this country, up until the close of World War II sintering remained—at least in the iron blast furnace plant—a reasonably convenient, but somewhat troublesome means of utilizing waste products, the disposal of which constituted a bit of a nuisance to most operators.

The last decade, however, has seen a diminishing supply of direct shipping hard ores resulting in a gradually greater dependence on lower grade ores which require concentrating or upgrading to yield a satisfactory blast furnace charge material. Other ores have come into prominence which are gratifyingly high in iron content, but are also so soft that they break down to fines in handling and must be agglomerated to prevent choking in the furnace and excessive dust losses. Thus, the depletion of the better grades of Minnesota ores has produced intense activity in sintering and pelletizing and in the evaluation of results obtained in the furnace by the use of these agglomerated materials. Then, a few years ago, came an added incentive when it gradually became apparent that in many cases, these agglomerated materials not only gave production rates as good as formerly experienced, but in many cases, the furnace tonnages soared far beyond anything previously experienced and with decreased coke rates and flue dust production. That is why agglomeration has suddenly achieved the status of an important production tool in the United States.

With so much attention being focused on these processes, there also came a realization that agglomerating practices in Europe and other parts of the world had been developed, due to necessity, somewhat more intensively than here and it became apparent that much help could be obtained for the problems facing us now from those who had faced and in varying degrees solved similar problems during the past twenty or thirty years.

It is interesting to note historically that, while the art of sintering progressed very rapidly from the time of its original development, pelletizing developed much more

TABLE I

Screen analysis of typical fine ores

Retained on A.S.T.M.	For sintering		For pelletizing	
⅜ in.	4.1	2.3	—	—
⅛ in.	2.3	3.8	—	—
7 mesh	11.7	18.2	—	—
18 mesh	7.0	7.1	—	—
35 mesh	27.1	17.9	—	—
45 mesh	18.2	12.6	—	—
100 mesh	20.3	23.6	0.4	1.2
170 mesh	2.1	5.0	11.6	16.7
200 mesh	4.1	3.1	n.d.	n.d.
230 mesh	3.1	5.4	11.3	16.6
230 mesh	—	—	76.7	65.5

slowly. The first experimental work of any importance on pelletizing of fine ores was done in Sweden in 1912 and 1913. However, interest in the process lapsed and it was approximately 30 years before this work was taken up again and pelletizing developed into a commercial process.

It may be stated that the fields of application for sintering and pelletizing are fairly well defined by the screen analyses of the raw materials and generally speaking, the two methods are not competitive but rather supplementary, see Table I. However, as the development work in pelletizing progresses it seems possible that increasingly larger grain sizes of materials may be successfully pelletized. In the field of sintering, by the use of improved mixing methods, increasingly finer sizes of materials are being successfully sintered at acceptable production rates. A fairly recent development, pellet sintering, offers promise of combining some of the best features of both processes. Apparently this was first tried at Babbitt about 1921 and has recently been revived at Star Lake.

IMPROVEMENTS IN SINTERING PRACTICE

Sintering on a straight line travelling grate sinter machine is by far the most extensively used means of agglomerating ore fines. Although these machines have been in use for many years, a number of improvements, both in the machines and methods of operating them, have been made known in this country only recently. One class of improvements which is of greatest interest is that which results in increased sintering rates per unit area. Such increased rates are obtained by increasing the amount of air passing through the bed per unit of area since the rate of sintering depends upon the rate of combustion of the fuel contained in the mix.

One of the most satisfactory ways to increase the production rate of sinter per unit area is by increasing the bed permeability. For a given bed depth, the permeability is a direct function of the amount of air flowing through the bed and an inverse function of the amount of suction required to pull this air. Thus an increase in permeability gives a higher sintering rate without a requirement for a higher amount of suction. This means that increased fan power is kept to a minimum. Where the sinter mix contains a large amount of very fine materials, a markedly improved permeability can be obtained by "micropelletizing" these fines. This is done by secondary mixing in a drum, Figure 1, similar to that used for pelletizing. This device, when the proper amount of water is added, produces very small seed pellets from the finest material and leaves the coarser constituents relatively unaffected. This not only gives a higher permeability, but reduces the amount of dust passing through the grates of the sinter machine.

This principle has been extended further by Jones & Laughlin in their experiments on pellet sintering, a procedure which can be used where all of the ore is very fine. The ore is formed into small pellets of perhaps ⅛-in. in diameter and then is sintered under conditions that fuse the pellets together. This mass is quite porous and has advantages in ease of reduction as well as having a very high permeability on the sinter machine. Another method of improving permeability is to avoid, as much as possible, any compacting of the bed as it is laid onto the sinter machine. It is known that the swinging spout causes a certain amount of compacting and that this occurs to a greater extent near the middle of the bed than at the two sides. The wider the machine, the greater is this effect. Because of this, the swinging spout has been largely replaced in Europe by the roll feeder. The mix is distributed with a short drop onto the feeder by an oscillating conveyor belt. Then a short drop from the roll feeder places the material evenly on the sinter strand. This combination of two short drops gives very little compacting and practically eliminates lateral variation in the permeability.

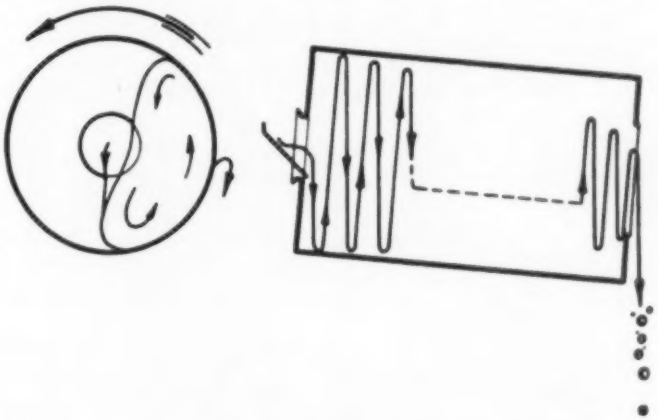


Figure 1 — Lines show motion of material in pelletizing drum.

Another method for increasing the rate of sintering is to cause as much of the fan air as possible to pass through the bed of sinter mix. On many machines in operation today, a large percentage of the gas handled by the fan is false or leakage air which enters the system principally through the seals between the pallets and the windbox, the dust legs on the windboxes, and the dust legs on the dust collectors. Published reviews of existing practice on average continuous sintering machines in this country estimate the leakage air handled by the fan to be 50 per cent or more. Windbox seals are now available which permit not more than 5 per cent leakage of air. These seals have a positive pressure of a seal strip on the bottom of the pallet against

a corresponding seal strip at the top of the windbox frames and are usually continuously lubricated. Also available are double gated and screw type dust legs which eliminate air leakage at this point.

A third method of increasing the sintering rate is by the use of higher windbox suction to achieve greater air flow. Higher windbox suctions have been made practical by developments in sinter machines and auxiliary equipment which have reduced the air leakage to a very small value. The rate of sintering is not directly proportional to the windbox suction, but over a considerable range, it is proportional to the 0.5 or 0.6 power of the suction. At some point, which is often around 40 in. of water, the curve of sintering rate versus windbox suction levels out as a result of the compacting effect of the higher suction on the bed. Obviously the use of higher suction to increase sintering rate requires increased fan power and this factor must always be balanced against the saving in size of the sinter machine which it permits.

Another recent improvement in sintering practice has been the development of larger sinter machines. The 8-ft wide machine is rapidly becoming standard for sintering tonnages of iron ore in excess of approximately 2000 per day. The use of a large machine in place of three or four small ones permits better control of the sinter production, simplifies the feeding problem, reduces the number of pieces of auxiliary equipment required, and decreases the maintenance. Although there may be some loss in flexibility, as far as rate of production is concerned this is not particularly serious, since the rate of production of a sinter machine can easily be varied by reducing the number of operating turns per week.

A number of improvements in the durability of the sinter machines and auxiliary equipment have been made. Although not new, the use of a separately added hearth layer is only recently receiving serious consideration in this country. A hearth layer consists of a layer of material containing no fuel, which is usually screened and sized sinter, but sometimes is sized ore. It is laid on the grates ahead of the point where the sinter mix is added. It serves three important purposes, but the most important of these is that it greatly increases the life of the grate bars and pallets. This is, of course, due to the fact that the combustion stops when it reaches the hearth layer, and this is usually about 1½ in. from the grate bars themselves. As a result, ordinary cast iron or low alloy iron can be used for these parts; otherwise many operators of sinter machines have found it necessary to go to high alloy grate bars in order to avoid excessive replacements and downtime. The other advantages of the hearth layer are that it reduces the amount of fines which is drawn through the grates and that it causes the sinter to come off the grates easily without sticking.

Figure 2 — Lowering sprocket prevents contact between pallets at discharge end of machine. Also shown is grease seal strip on bottom of pallet.

Figure 3 — Pallet for pellet-burning machine illustrates grate bar design.

Another device which improves the life of the pallets is the lowering sprocket, Figure 2, at the discharge end of the machine. This device engages the pallets when they reach the end of the sinter strand and separates them from each other while they are lowered to the return track. In its absence, each pallet would drop over the end to be stopped by impact against the pallet below it. The use of a lowering wheel, not only reduces the stresses of the pallets themselves, but gives a reduced impact loading on the framework of the machine and the building at the discharge end of the machine.

Warping of grate bars has been reduced to insignificance, not only by the use of a hearth layer, but also by an improved grate bar design, Figure 3, in which the individual bars are short, very deep and locked at the ends. Warping and sagging of pallets has been eliminated chiefly by making the pallets more rugged where conditions are severe. On one 8-ft wide pellet burning machine, the individual pallets weigh over 6000 lb each.

One of the outstanding attributes of modern sinter plants is the greatly improved collection of solids from the main gas stream. Such improved collection decreases abrasive wear on the main fan and associated ducts. In order to decrease wear on the duct system, it is desirable to remove dust from the gas stream as soon as possible after the gases leave the machine. This is accomplished by having an individual dust collector on each windbox. The coarser particles are thus removed almost immediately. A secondary dust collector is then used to remove material which passes through the primary collectors. Another method of accomplishing this result is to make the main duct very large and perhaps brick lined so that it acts as a settling chamber for the dust. Besides reducing abrasive wear, this system also gives a very low pressure drop. In another system the dust is allowed to pass into the main gas duct, but is collected at the end of the duct by efficient cyclone separators which are lined with silicon carbide brick to give a long life or by electrostatic precipitators.

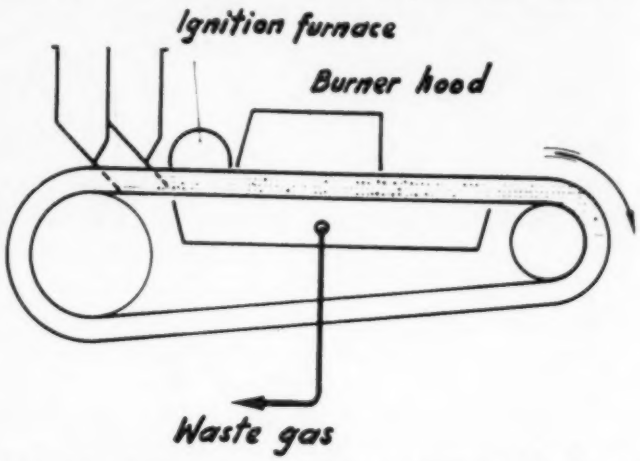


Figure 4 — This process replaces a portion of solid fuel with gas or liquid fuel in sintering.

A fourth class of improvements in sintering practice are those which improve the quality of uniformity of the sinter produced. One is through the use of improved methods of feeding the mix onto the sinter machine. The use of a roll feeder was mentioned before in connection with improved permeability, but it also permits a more uniform sinter because the permeability is less variable across the width of the machine.

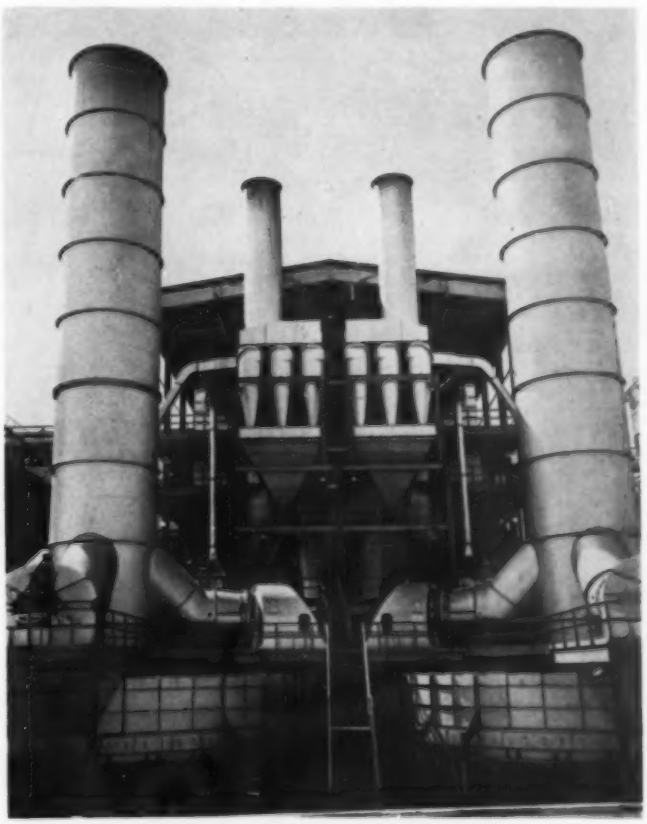
Investigation has also shown that improved quality and uniformity of sinter are obtained when improved ignition is used. In the sintering process the material being sintered is preheated by passage of the air through previously sintered material. This is true for all except the top layers, which are the ones first sintered. These layers must be preheated by other means if the sintering is to be of equal quality from top to bottom. If a short ignition time, of say 5 to 10 seconds is used, it is necessary to increase the amount of coke in order to get satisfactory sintering in the upper layers. This results in excessive heating and therefore slagging in the lower layers of the bed. To avoid this slagging and still obtain material satisfactorily sintered on top, it is necessary to use a long ignition furnace with an ignition time of preferably one-half to one minute.

Where excess unused gas is available, this idea can be extended even farther, Figure 4. By extending the ignition furnace over half or more of the length of the sinter machine, which is done in our process and design, the amount of solid fuel in the mix can be reduced by 25 to 40 per cent. Not only is slagging eliminated, but a more highly oxidized and therefore more easily reducible sinter is obtained. Another method of accomplishing this result is by what is known as double bedding. In this system the bed is laid in two layers with the upper layer, usually about ¼ of the total, containing a higher percentage of coke than the lower layer. An ordinary ignition time of one-half to one minute is used with this system. Elimination of slagging and a high degree of oxidation of the sinter are obtained along with reduced coke consumption in the blast furnace.

Double mixing was mentioned earlier as a means of obtaining a higher sintering rate. It also gives a better uniformity of sinter quality, due to the improved quality of mixing, which is a very important factor in sinter quality.

After good quality sinter has been produced, it is necessary to avoid degrading it by subsequent handling or treatment. An important means of accomplishing this is the use of a properly designed air cooler, Figure 5, for cooling the sinter. Air cooling avoids the shock cooling resulting from the use of water and also permits the handling of sinter by rubber belts, which give less mechanical degradation than buckets. The cooler itself should handle the sinter gently during cooling and at discharge.

Figure 5 — Circular air draft sinter cooler shows induced draft fans. In background are dust collectors serving the discharge end of sinter machines and hot sinter screens.



This, of course, coincides with the increasing importance of concentrates from low grade ores. These concentrates, often produced by magnetic means or flotation, are of necessity very fine in grain size. If an attempt is made to sinter these without some sort of pretreatment, the permeability is generally so poor that a very low sintering rate is obtained. To avoid this condition, it is usually desirable to pelletize these concentrates into relatively large particles. As a result these fine materials, which would be difficult to sinter otherwise, can be agglomerated at high rates.

The conventional method of producing green pellets has been to sprinkle the powder into a rotating drum, Figure 1, and spray it with water as it proceeds through the drum due to a slight tilt of the axis of the drum. In the process of going from one end of the drum to the other, the powdered material becomes balled (pelletized) and is discharged from the end of the drum in the form of green pellets of widely varying sizes. If balls of a reasonably uniform size are desired, it is necessary that the material discharged from the drum be screened and a large percentage of it recycled back to the feed end of the drum. The quantity of undersize recycled is often 300 or 400 per cent of the quantity acceptable as product.

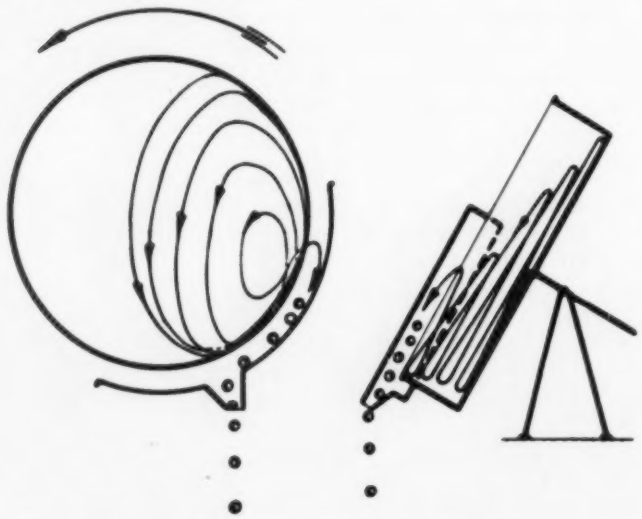


Figure 6 — Lines show motion of material on balling disc.

Recently a new device for producing pellets has come into prominence. This is the pelletizing disc or pan, Figure 6, first used for metallic ores in 1951. It consists of a pan slowly rotating on a tilted axis which is fed with the powdered material in question. The powder is sprayed with water as in the pelletizing drum. The action of the rotating disc, however, has a classifying effect and produces a segregation of pellets of various sizes. The larger pellets roll toward the rim of the disc and the smaller ones stay near the center or beneath the larger ones as shown in Figures 7 and 8. As a result of this action, when the disc becomes filled, only the larger pellets are discharged over the rim. This action gives quite a uniform pellet size and generally eliminates any necessity for screening the pellets. It may be well, however, to caution that the pelletizing disc is not a cure-all for mixing problems. It is a specialized piece of apparatus which, because of its classifying action, is not as good for mixing most ores as is a drum or pugmill.

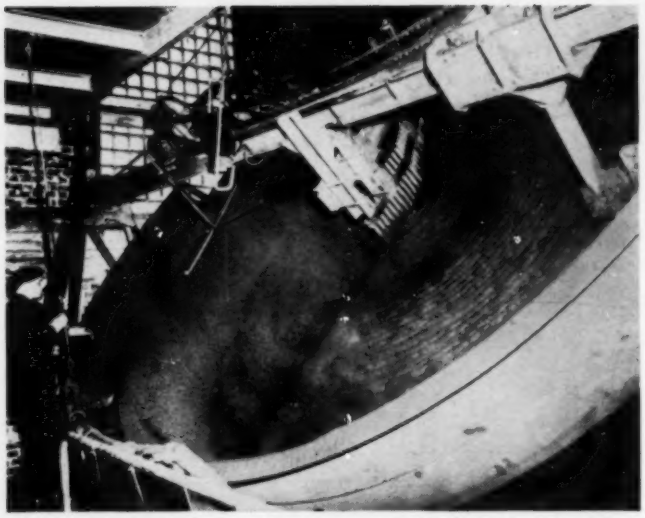
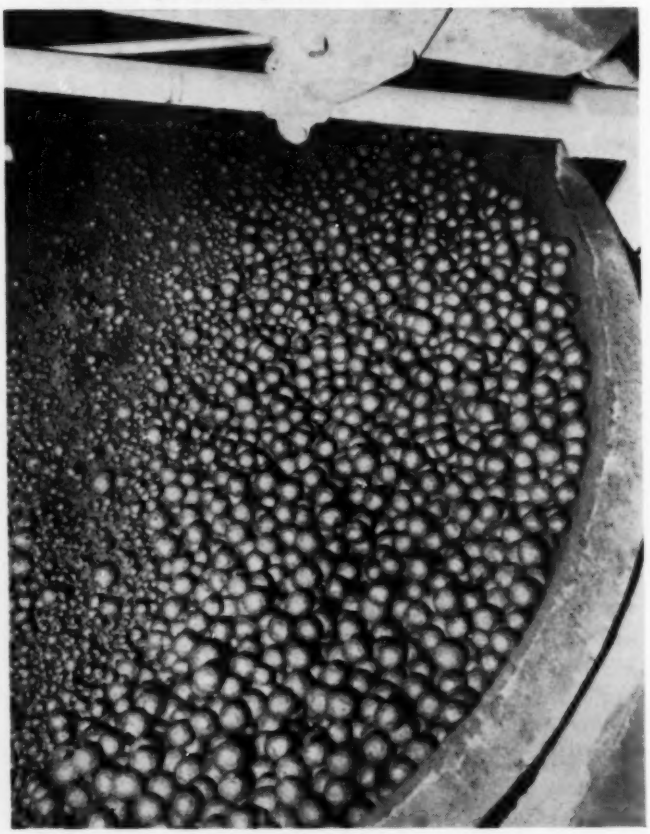


Figure 7 — This 16-ft diameter pelletizing disc produces pyrites concentrate pellets.

The size limits in which pelletizing discs may be built are not known. The rolling action produces satisfactory pellets in discs at least as small as 2 ft in diameter and as large as 16½ ft in diameter. These are the extremes in sizes with which we have had any experience. The capacity per square foot of disc area decreases somewhat in the larger sizes so that it may not be practical to go to sizes much larger than at present. The production per square foot is approximately 70 per cent as great in the large disc as it is in the smaller one. A wide

Figure 8 — Operating photograph taken at a thousandth of a second shows the size classification in a six-ft diameter pelletizing disc.



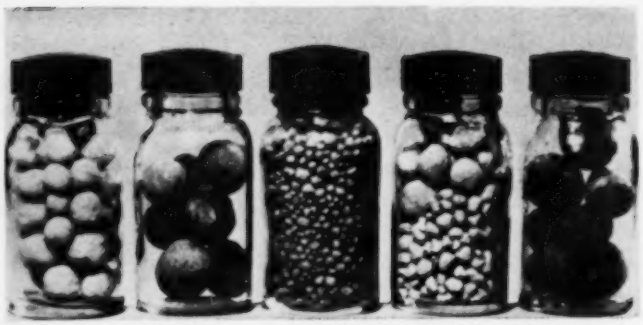


Figure 9 — Pellets can vary from less than ⅛-in. up to over 1¼-in. diam.

variety of materials, even including water soluble materials, can be pelletized on a pelletizing disc. It is usually necessary, however, to have 50 per cent or more of material which is –200 mesh in size. If sufficient fine material is available, a reasonable amount of coarse material does not seem to have a bad effect. The coarser particles merely act as nuclei for the formation of balls. Commercial pellets are being produced varying in size from less than ⅛ up to over 1¼ in. in diameter and in a wide variety of materials, Figure 9.

Compared to pellet formation, which is a very simple process, pellet burning is more complex. It can be carried out either in a shaft furnace or on a traveling grate sintering machine. Although the shaft furnace, at present gives the highest thermal efficiency, the sintering machine permits greater flexibility, is less subject to long delays due to production difficulties, and makes less demands on the strength of the wet pellets and on the operators. This discussion will be confined to improvements in pellet sintering on sintering machines.

One of these improvements which has been thoroughly tested on a pilot plant scale, and will shortly go into commercial operation is the sintering of pellets using only external fuel, Figure 10. In this process no solid fuel and no binder is incorporated into the pellets or coated on the outside of them. Only oil or gas is used as a fuel. A special device has been developed for shockless feeding of pellets onto the machine. A long furnace covers most of the sinter machine and contains the burners which supply the sintering heat. This process uses down draft sintering and the hot gases from the burners are sucked through the bed of pellets. The advantage of the method is that the absence of any reducing action of solid fuel in the pellets results in obtaining pellets with a very high state of oxidation.

Reserve Mining Co. makes use of up draft pre-drying in their pellet sintering process. The advantage of up draft drying is that a thicker bed of pellets can be used because water does not condense on the pellets at the bottom of the bed and soften them. The water is evaporated first from the bottom pellets so that they become harder rather than softer, but sometimes brittle, during the drying process.

Still greater bed depths may be made possible by a process under development by the Cleveland Cliffs Iron Co. In this process, updraft pellet burning is used. A thin ignition layer is first laid on the grates and ignited with a regular ignition furnace. A layer of pellets containing fuel is then laid down on top of this ignition layer and air is blown upward through the bed. When burning has progressed near the top of this layer, another layer is laid on and ignited from it. This procedure is continued until as many as four layers have been placed on the grates. A considerable overall bed depth is obtained by this procedure. A possible disadvantage may be the complex pellet feeding arrangement.

Pellet sintering machines now under construction employ recuperation of heat from the hot gases to improve the thermal efficiency. Such well designed heat recuperative systems are capable of giving thermal efficiencies approaching those obtainable with shaft furnaces.

SUMMARY

In conclusion, it can be stated that the past decade has seen increasing attention being given to details of the sintering process; details which were previously regarded by many as being unimportant; and this increased attention has produced some very satisfactory results. However, without in any way wishing to deter the progress of experimental work, it is advisable to point out that excessive control can be uneconomical. It must be remembered that the best sinter in the world is still a raw material, not a precision product, and variables within reasonable limits will always exist.

In the improvement of existing practice and in the design of new plants, proper mixing is probably the most rewarding field for close study. Very significant changes in sintering rates can frequently be obtained by changing mixing methods and more and more we are coming to realize that the usual practice of sinter mixing in a pugmill alone can frequently be improved.
The authors wish to express their appreciation for much of the material employed in the preparation of this paper to Doctors H. B. Wendeborn and K. Meyer of Lurgi Chemie in Frankfurt, Germany.

DISCUSSION

PRESENTED BY

FRED DARNER, Chief Engineer, Manufacturing Div., Republic Steel Corp., Cleveland, Ohio

H. E. ROWEN, General Manager, Dwight-Lloyd Div., McDowell Co., Inc., Cleveland, Ohio

W. E. TRACY, Sturtevant Div., Westinghouse Electric Corp., Chicago, Ill.

GEORGE L. FRENCH, Master Mechanic, Bethlehem Steel Co., Bethlehem, Pa.

C. M. SQUARCY, Blast Furnace Superintendent, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

EDWIN N. HOWER, Manager, Industrial Dept., Dravo Corp., Pittsburgh, Pa.

Fred Darner: We have been conducting pelletizing experiments at Reserve Mining for approximately four years. We have learned many things about pelletizing taconite ore, but still have not solved all the problems so as to have a continuous and smooth operation. I particularly like Mr. Hower's comments on the disc and the size of the pellets produced.

When control is good, pelletizing seems to be a very easy and simple operation. It takes time for the opera-

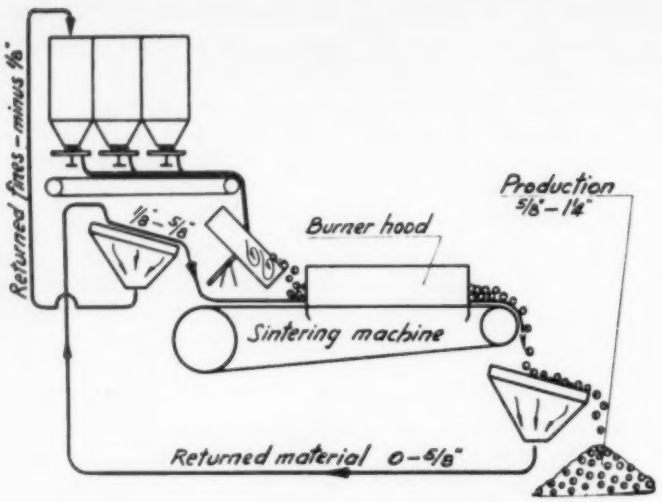


Figure 10 — Schematic shows section of pelletizing plant.

tors to get their "hand in" and the "know how" on what is needed to continuously produce good pellets.

At the present time, we are producing at Reserve about 1200 tons per day, and early in 1956 will produce about 13,000 tons per day. These pellets will be made in eighteen drums, 9 ft in diameter and 20 ft long.

I would like to ask Mr. Hower what is the peripheral speed of the drum that you mentioned here?

Edwin N. Hower: On the pelletizing discs the peripheral speed ranges between 100 to 300 fpm.

H. E. Rowen: I would like to add my personal congratulations to the authors on the studies which have gone into this paper and on the fact that they have gone well back in developing the history of sintering, and the natural improvements in it as we have learned about details as the effect of the burning heat, arching, or whatever you want to call it, of the bedded material under suction and of the effect of pellets on bed permeability. There are a great many ores or physical forms of the same ores and proper bed permeability is achieved only when there is proper preparation of them.

Some of these ores can be made into balls or pellets within the economical operating limits and some cannot and whether we do or not may also depend on the metallurgical and chemical reactions that must take place at the faces or within the ore particles.

I was extremely pleased to note the belief, which I know is held by a great many people, that a constant increase in fan pressures does not mean faster sintering in all cases. We must remember when we have leakages through the orifices formed between the moving pallets and windbox tops, or down the pallet sides between the material and the side, with increased pressures and the consequent increased flow of gases, the rate of flow through these leakage orifices is increased by well known laws. The orifices remain constant. However, the relative orifice passages for air through the sintering or pellet bed probably greatly diminish with the increased packing caused by higher pressures on the bed, and the resultant tortuous and much longer passages within it may well decrease the air flow through the bed while proportionally increasing it through the leakage openings. This brings forth the basic thought that in sintering a mixed ore or pellet, you do not get your increased production on the machine by simply using larger fans but in a well thought out preparation section.

I do hope, and I know, the reader will not leave with the thought that all the improvements and developments in sintering or pellet treatments have come from Europe because American engineers and American research men are on top of this also. I have been fortunate in spending the last month in Germany, Belgium and England and I had a chance to stop in a few of the sintering plants. The men over there are quite frank in saying they look to America for help with their problems and when they come over here, they get it.

The sliding windbox seal, lubricated in the crude way it was done in 1908 when the first machine with one was built, wore badly and was abandoned for a time, but who knew then where to locate them or how to lubricate them and it is as stated, probably the most efficient seal we know of today and our idea of location and lubrication is only to take the wear out.

The roll feeders are not an overseas new. The first were used by the Ohio and Colorado Smelting Co. in 1912. They did a good job then but we improve things and forget about them for awhile. A lot of things we have improved have made them more workable and others have not, but the feeders do a good job on certain types of charges.

I would like, without taking issue with the writer's remarks on pelletizing discs or mixing discs or whatever you want to call them being of little value as mixers, to state a belief that for certain ore mixes, when the speed, inclination, the method of feeding the ore mix and the method of maintaining the surface on which the ore tumbles and rolls and leaves is maintained properly, they are very good mixers.

Some of the work in the United States being done by or for some producing companies, indicates that it is a good mixer and may, in their plants, replace duplicate sets of double shaft pug mills and the rotating mixing drum.

W. E. Tracy: I would be interested in knowing the type of fans that are used, and the increased suctions that are required with the use of the higher collection.

George L. French: I would like to ask two questions. Since sintering is used to make the blast furnace work more efficiently, I was particularly interested in your use of full external fuel as opposed to fuel contained within the pellets.

First, have you used pellets manufactured by this process in a quantity that would enable you to evaluate their advantages or disadvantages over those made with fuel contained within the pellets?

Second, I would like to know what depth of bed you can get by use of external fuel only.

C. M. Squarcy: This paper stresses the use of ore and external fuel in the production of sinter. A blast furnace operator is faced with the use of coke in his flue dust that is a source of fuel and is a means of improving permeability. The manufacturer must also realize that we must use the flue dust and its handling is important in the production of sinter.

Edwin N. Hower: There are several things which we omitted mentioning in the paper. One of them is that every definite statement about sintering should be prefaced by saying "for this particular ore, so and so appears to be the best." The variations between ores, as we know and as Mr. Rowen mentioned, are so great that it is very, very difficult to make an absolute statement that will apply to all types of ore.

As Mr. Squarcy reminded me, we did not mention the advantages of sinter in the open hearth. They are well known and I do not think need any more comment.

Mr. Squarcy also mentioned that most plants are faced with the problem of using flue dust, and that of course is true. Flue dust in the amount of 10 or 15 per cent can be mixed with most ores without appreciably changing the sintering rate, and in some cases, the percentage may be higher. Naturally, the carbon content of the flue dust will reduce the amount of fuel which must be added.

One of our plants is now using a very extensive stock of flue dust. Those results will be reported in a later meeting, but the sintering mix contains approximately 50 per cent flue dust mixed with Mesabi ore and very high production rates are being achieved.

To answer Mr. Tracy's question, straight radial bladed fans are principally being used in this country. However, more attention is being given to fans with backward curved vanes and some of the plants going into operation in the next year or so, will have this type of fan. In Europe, because power is relatively more expensive and a slight power saving can mean a considerable operating economy, they use a single stage blower with backward curved vanes and employ a construction similar to that used for blast furnace blowers in this country. It is a very rugged, very heavy and very expensive piece of equipment, but the power saving seems to justify its use over there.

To answer Mr. French, regarding the gas firing of pellets, I do not have any quantitative results on production runs, but the benefits have been well established by extensive pilot plant work. As far as bed depth is concerned, external fuel firing does not appear to be a limiting factor in bed depth.

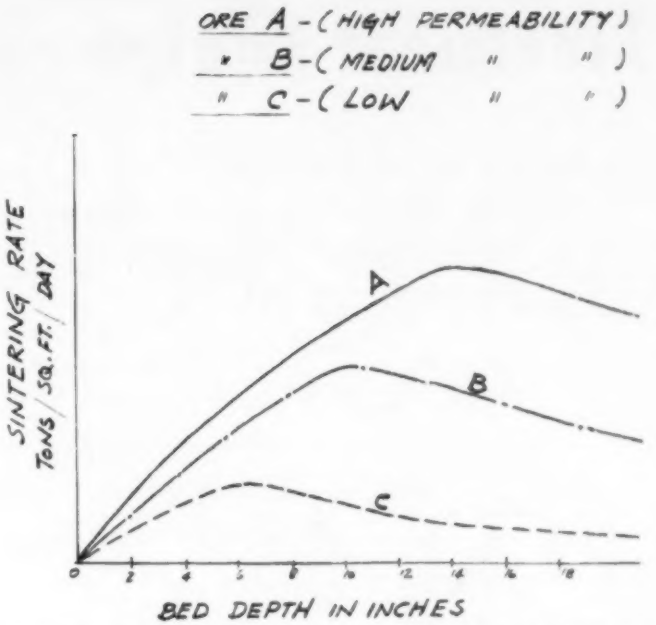


Figure 11 — Sintering rates are a function of the bed depth. There is an optimum depth for a particular ore.

In sinter production, there is an interesting relationship between bed depth and sintering rate. See Figure 11. The production from a sintering machine improves as the bed depth is increased up to an optimum figure. Then it levels out and, after a certain depth is reached, any increase in bed depth will result in a decrease in total production even though the suction pressure be increased substantially. The depth at which maximum production can be achieved varies considerably for different ores.

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AISE CONVENTION AND EXPOSITION

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Electrical Equipment for Auxiliary Drives of hot strip mills Part II

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. . . . this is part II of a three part article which will appear in successive issues of the Iron and Steel Engineer . . . . with the heavy investment required by a continuous mill, careful selection of the equipment for the auxiliaries is n cessary for the economical overation of such mills . . . .

▲ APPLICATION of motors and controls on hot strip mill auxiliary drives is discussed in Part II of this article. Part I dealt chiefly with motors, their characteristics and controls. In it was explained how the mill auxiliary type d-c motor, by virtue of its rugged mechanical and electrical construction, is the accepted industry standard. Mentioned also were the special type d-c motors developed for runout tables and coilers where space is at a premium, protection against water sprays is essential and where motor torque peaks as high as five times rating are often essential for good performance. A-c motors as applied to hot strip mill auxiliaries, it was pointed out, are in the minority.

The two basic types of d-c motor control: "Constant Potential" and "Adjustable Voltage" were also examined. The conclusions, as stated, were that cost and space considerations favor constant potential control wherever the drive requirements can be met by this type of control; but, that adjustable voltage is definitely superior from the standpoints of performance, reliability and flexibility. Therefore, in view of the everpresent objective to maintain high tonnage from the hot strip mills, the extra money for adjustable voltage equipment is generally considered well spent where that extra bit of performance and reliability are of major importance.

The pumpless mercury arc rectifier is now replacing the motor-generator set as a source of 250-volt, d-c constant potential power supply, according to Part I of this article. Mentioned also was the advent of x-ray thickness gage and the more recently developed width gage to better control quality and reduce scrap.

EVALUATION OF DRIVE REQUIREMENTS

Experience is an indispensable ingredient in the proper selection of motors and control to all steel mill auxiliary drives. The ultimate decisions usually and naturally belong to the user customer. He often relies heavily upon the mill builder's recommendations because of the mill builder's intimate knowledge of the drives and his experience with existing similar drives. Engineering recommendations and the experience of the electrical equipment manufacturer also are brought to bear upon many of these decisions. There are two reasons why experience is so important:

1. Friction, the great variable, must be considered on most drives. It may vary four to one, depending upon factors which cannot be accurately evaluated or predicted, such as: temperature, lubrication, condition of bearings, dirt, etc. Field experience will help in the evaluation of the friction that may be encountered under normal operating conditions.
2. Actual performance requirements can be best understood with the aid of broad field experience on many mills.

A few basic calculations are usually in order, however. Consider the first questions: What size motor is required? What shall the gear ratio be?

A trial motor selection is usually made. Gear ratio is calculated as the simple ratio of motor speed divided by desired load speed. Load torque is estimated, then divided by gear ratio and assumed gear efficiency to arrive at the required motor torque. Then the familiar formula:

$$\text{Motor Horsepower} = \frac{\text{Motor torque in lb—ft} \times \text{motor rpm}}{5250} \qquad (4)$$

By comparing this calculated motor horsepower with that of the trial motor selection, it will be seen whether or not another motor should be used and a repeat calculation made.

This approach to the problem is a very excellent one. It is fundamental. The calculated horsepower may sometimes, however, not represent the actual required nameplate horsepower rating of the motor; but, if not, it will at least point to the answer. Considerations such as follows should be taken into account.

1. If the load is very intermittent, such as on a finishing mill table side guide which may not be moved for hours after being adjusted for a particular schedule, it will be good engineering to count on using some of the motor peak load capacity. Thus the nameplate rating of the motor may be smaller than calculated. Bearing in mind that standard mill auxiliary type motors have breakaway torques ranging from 35 to 50 per cent of rated torques, it would certainly be safe to apply a 5-hp motor to a calculated load of 10 hp, or even bigger.
2. If it is difficult to evaluate load torque in the first place within any reasonable degree of accuracy, a higher nameplate horsepower may be the logical answer in order to be safe.
3. On continuous loads, temperature rise will demand force-ventilation, or perhaps a larger motor since 75 degrees C rise for 1 hour is what standard, totally enclosed, non-ventilated, mill type motors are rated, and they must be force-ventilated to carry their nameplate horsepower continuously.

With reference to ventilation, on a continuous hot strip mill with the conventional four or five roughing stands ahead of the finishing train, the only force-ventilated auxiliary motors are those at the flying shear, and perhaps at the coilers. On the semi-continuous type of mill with a reversing rougher instead of the four or five roughing stands, force-ventilation is used on the live table and screwdown motors. These motors are controlled by adjustable voltage and must reverse quickly with every pass of the strip through the rougher. The RMS value of motor current on such drives may approach 100 per cent. Force-ventilation is, therefore, required. On continuous hot strip mills, the intermittent non-frequently-repeated loads are most typical.

Each auxiliary has its own particular type of duty. These are described briefly in Table IV. With a reasonably accurate description of motor duty, such as Table IV, there should be little difficulty in deciding what types of motors and controls should be used on each; see Table V.

TABLE IV
Duty Requirements of Auxiliary Drives

Drive	Duty
Furnace slab pushers	"Start-Stop", very intermittent—running a few seconds out of every one or two minutes. Torque subject to moderate variations; high friction component.
Furnace slab delivery tables	Continuous operation at light loads, with intermittent loads superimposed as slabs reach table. Moderate to low friction, high inertia.
Slab turnarounds	"Start-Stop", very intermittent — running a few seconds every one or two minutes. Torque somewhat variable.
Roughing mill tables (continuous hot mill)	Same as furnace slab delivery tables.
Front and back reversing rougher tables of semi-continuous mill	Frequent rapid reversals with every pass, wide speed range, high accelerating and decelerating torques, substantial inertia (rolls plus strip), low friction, rms duty high, adjustable voltage drive to approximate mill speed points.
"Delay" or "Intermediate" tables	Run most of the time at moderate loads, starting and stopping perhaps every two minutes. Moderate to low friction, high inertia.
Table side guides	Reversing, start-stop; very intermittent — perhaps not run for hours; subject to wide variations in torque. Considerable friction.
Screwdowns (continuous hot mill)	Reversing, start-stop very intermittent — subject to frequent jogging. Considerable variation in loads. Occasional high speed operation at light loads.
Screwdowns of reversing rougher of semi-continuous mill	Frequent starts and stops, must position screws for every pass, need high accelerating and decelerating torques, substantial inertia, moderate friction, rms duty high, wide speed range reversing adjustable voltage drive.
Loopers	Stalled operation 90 per cent of the time. Torque adjustable and is constant.
Flying shear	Rapid start-stop, intermittent but very high peak loads when starting and stopping. Torques high but predictable, low friction, high inertia.
Crop shear	"Start-Stop" very intermittent, one cut every one or two minutes. High accelerating torque, inertia loads — some speed adjustment but no speed matching.
Runout tables	Practically continuous at light load, occasional peak loads when accelerating and decelerating due to roll inertia; low friction, high inertia, adjustable voltage drive to match mill.
Pinch rolls at coilers	Almost continuous operation with start-stop every two minutes on some coolers, running load approximately 100 per cent. High peak loads during acceleration and deceleration. High inertia. Adjustable voltage drive to match mill.
Down coiler mandrel drive	Similar to pinch roll motor duty, except motors must have field range for coil buildup.
Down coiler wrapper rolls	Generally similar to that of pinch rolls.
Upcoilers (mandrel driven)	Generally similar to that of downcoiler motors.
Piler pinch rolls	Continuous at light loads with loads superimposed — moderate inertia — speed must match mill.
Coil conveyor	May run continuously, although stop briefly with every coil (1 or 2 minutes) high friction torque subject to considerable variation. Perhaps some speed adjustment, cut not matched to that of mill.

FURNACE SLAB PUSHERS

A slab furnace usually has two slab pushers, each driven through a rack and pinion. See Figure 22. These may be operated separately or as a pair unit allowing the charging of either short or long slabs. Typical motor sizes are 50 and 75 hp.

Series-wound and compound-wound motors are both suitable for this service. Wide variations in load can be expected but actual motor speed is quite unimportant, torque being the basic requirement. Series wound motors are therefore considered by many as the natural choice because of their high torque capacity

TABLE V

Typical Mill Motors and Controls Used on Hot Strip Mill Auxiliaries

Drive	Motor	Control	Brake
Furnace slab pushers	Series or compound	RP	Series
Furnace slab delivery tables	Compound or shunt	RDB	No
Slab turnaround	Compound	RDB	Series
Slab squeezer	Compound or shunt — mill auxiliary or large mill type	RDB	Shunt
Roughing mill tables (continuous mill)	Compound or shunt	RDB	No
Reversing rougher tables (semi-continuous mill)	Shunt	WL	No
"Delay" or "intermediate" tables	Shunt	AV	No
Rotary crop shear	Constant or adjustable speed	RDB or AV	Shunt
Table side guides	Series or compound	RP or RDB	No
Screwdowns (continuous mill)	Compound or shunt	RDB	Shunt brake on some. No brake on others.
Screwdowns — reversing rougher (of semi-continuous mill)	Shunt	AV	Shunt
Loopers	Shunt	AV	No
Flying shear	Two shunt — or one, direct-connected, mill type (forced-ventilated)	AV	No
Runout tables	Shunt, special mill type	AV	No
Pinch rolls at coilers	Shunt (forced-ventilated)	AV	No
Coiler mandrel drives	Adjustable speed — shunt (forced-ventilated)	AV	Shunt on some. No brakes on others.
Coiler wrapper rollers	Shunt, regular or special mill type	AV	No
Piler pinch rolls	Shunt	AV	No
Coil conveyor	Adjustable speed — shunt	NR	No

(450 per cent breakaway torque). There is no opportunity for them to run away for lack of load because considerable friction is always present. Furthermore, the travel in both directions is short and defined by limit switches.

Reversing plugging type of constant potential control is generally used and a series wound brake for holding. Rotating cam type limit switches are the natural choice since this is a cycle type of operation wherein a single movement of the master switch can initiate a complete cycle of forward movement and reversal to the starting position.

FURNACE SLAB DELIVERY TABLES

These tables are driven by shunt or by compound wound motors. Since speed control is not particularly important, compound wound motors are suitable despite their inherent speed regulation. Shunt or stabilized shunt wound motors will provide a convenient means of adjusting speeds however. Perhaps the only time this would be necessary is during the initial setup or installation of the tables when an adjustable motor field resistor located on the constant potential control panel would suffice.

Normally the tables run continually in a forward direction. Occasionally jog-reverse operation is necessary, therefore, the conventional reversing dynamic braking control is used.

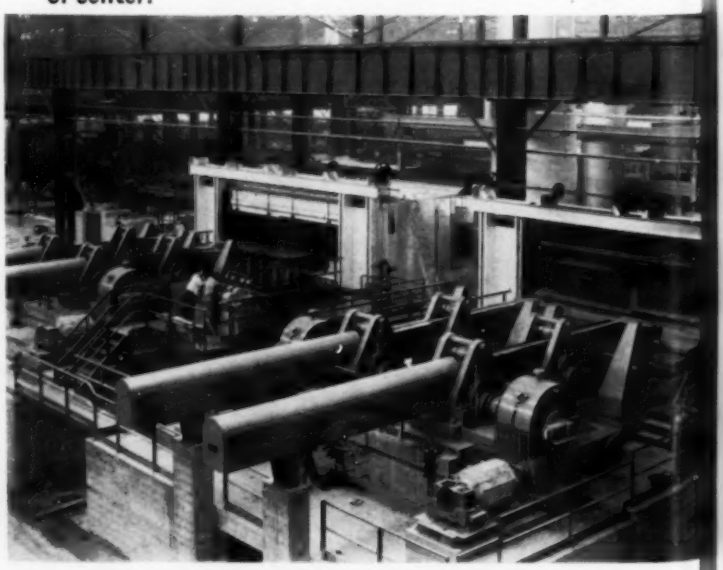
SLAB TURNAROUND

For broadside rolling there always is provision ahead of and behind the broadside stand for turning the slab around through 90 degrees. This is done in several different ways. A pin or stop may engage one corner of the slab as it is pivoted about this corner by the action of the tables. Skew tables have been used. The most common method is to use a lift and turn mechanism, the lift being hydraulic and the turning by compound wound motor.

In a typical installation, a starting button or master switch will initiate the operating cycle wherein an electrically controlled hydraulic valve will raise the turntable, a limit switch will then start the motor rotating the table through 90 degrees. A rotating cam type limit switch will stop the motor, set the brake and operate the valve control allowing the table to lower to its original position. Successive slabs are all turned in the same direction.

Compound wound motors ranging from 7½ to 25 hp have been used on the lift. Although the turning is always in the same direction, reversing dynamic braking control is generally supplied for emergency reverse operation.

Figure 22 — The slab pushers may be operated singly with short slabs or in pairs for large slabs. Note motor with brake in front and at left, with operator's station left of center.



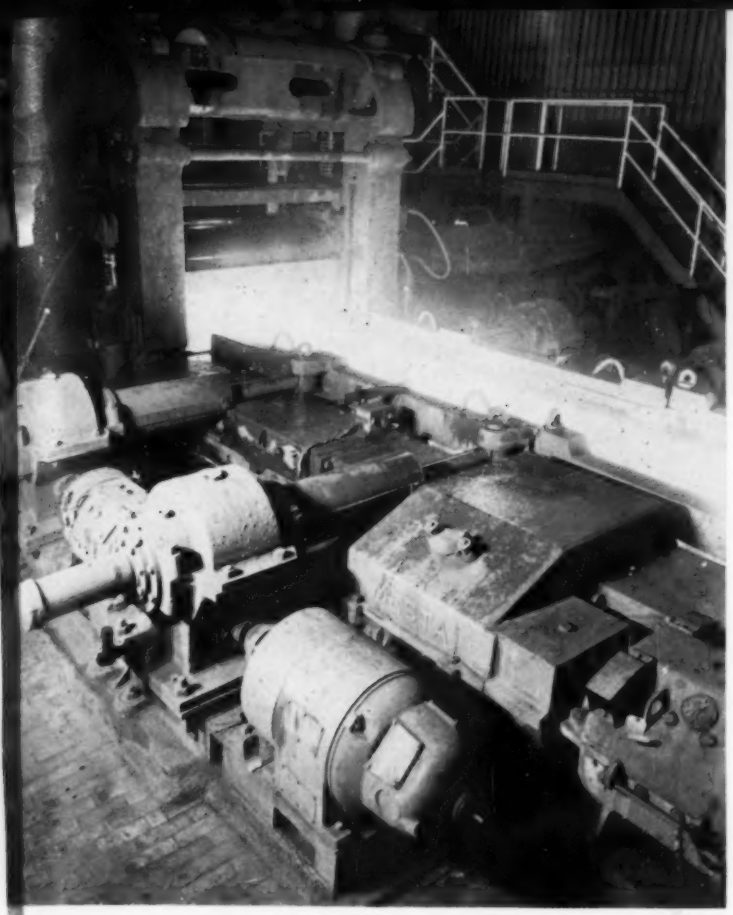


Figure 23 — Scalebreaker, preceding reversing rougher, has left side guide drive with 25-hp, 650-rpm, compound-wound, 230-volt, d-c motor between the two gear boxes, and power selsyn rated 4-pole, 20 hp, 650 rpm, 440 volts, 60 cycles in the immediate foreground. This power selsyn electrically position-ties the left side guide to the right side guide drive (not visible) so that both move in and out together at all times, maintaining equal relative positions with respect to centerline of table.

It is of course possible to motor drive the lift also. This has been done on several installations, although it can hardly be considered typical.

SLAB PUSHER

Slab pushers are sometimes used to insure positive entry of the slab into the broadside stand in the proper position. The typical pusher is of the screw type driven by a compound-wound motor with reversing dynamic braking control including armature shunt slow down.

The operation is programmed by a reversing cam type limit switch, moving slowly until the slab is engaged, then moving it rapidly into the mill and finally reversing at high speed to the original position.

SLAB SQUEEZER

The purpose of the slab squeezer behind a broadside stand is to square up the slab, truing it as to width and to flatten it. Slab width reductions up to about three inches are possible, thus permitting the rolling of several widths of strip from one width of slab. Squeezers have been compared with edgers by the expression: "Edgers hold width but slab squeezers change width."

The squeezing is done by two heavy rams acting on the sides of the slab. A large (200 to 700-hp) motor drives the rams through a high gear reduction and an eccentric shaft. During this squeezing operation, the slab is held in position by a hydraulic hold-down, controlled by electric thruster-operated or solenoid-operated valves.

Compound or shunt-wound, constant speed, short time rated motors on constant potential, 250-volt, d-c shop supply are suitable for this application. In the high horsepower sizes, consideration should be given to adjustable voltage control and/or 600-volt motors. Where frequent operation is necessary, the use of large accelerating contractors should be avoided wherever practical considerations permit. The added flexibility of adjustable voltage control is, of course, always welcome.

A conventional constant potential control equipment will essentially consist of: a reversing dynamic braking control panel with armature shunt feature, rotating cam type limit switch, magnetic brake, and master switch. Since this is a 360-degree, eccentric-rotation type of operation, the rotating cam type of limit switch is called for. Normal operation is in the forward direction only and the reversing feature is included only for occasional emergency reversal purposes. Provision for armature shunting is included primarily to achieve a light-load slow positioning speed as the drive returns to the starting point.

Small adjustment motors are also part of the squeezer electrical equipment. These may be a-c or d-c. The duty is very intermittent; and, the control therefore is kept very simple but reliable.

Figure 24 — Simplified diagram shows basic electrical connections of power selsyns on d-c motor driven side guide drive.

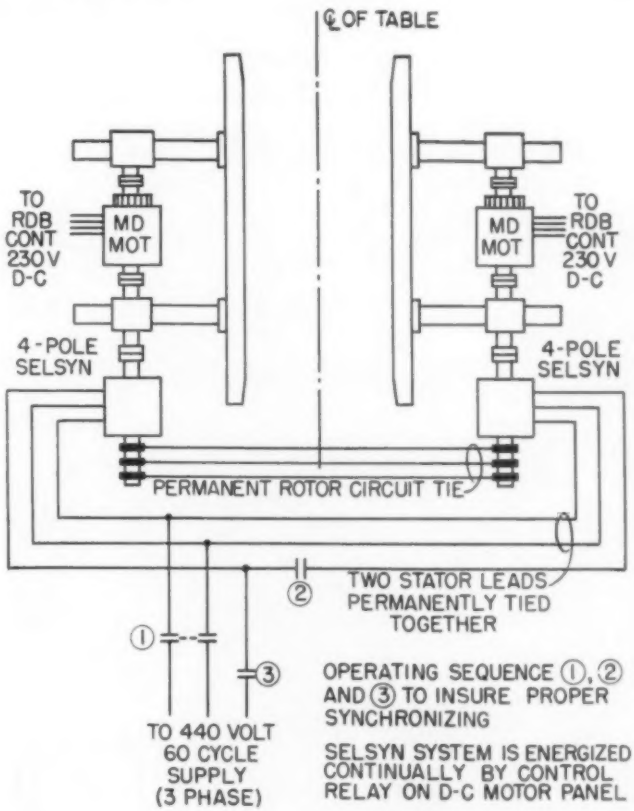

℄ OF TABLE
TO RDB CONT 230 V D-C
MD MOT
MD MOT
TO RDB CONT 230 V D-C
4-POLE SELSYN
4-POLE SELSYN
PERMANENT ROTOR CIRCUIT TIE
② TWO STATOR LEADS PERMANENTLY TIED TOGETHER
①
③
OPERATING SEQUENCE ①, ② AND ③ TO INSURE PROPER SYNCHRONIZING
TO 440 VOLT 60 CYCLE SUPPLY (3 PHASE)
SELSYN SYSTEM IS ENERGIZED CONTINUALLY BY CONTROL RELAY ON D-C MOTOR PANEL

Figure 25 — Roughing mill approach and front tables are driven by fifty-one 10-hp 600 series motors with one on each individual roll.

SIDE GUIDES

Side guides are used to direct the steel into the mill stands, coilers and piler.

Series or compound-wound motors are generally used with either reversing plugging or reversing dynamic braking control.

Usually the lift and right side guides are mechanically connected, thus requiring a single motor to drive them. Occasionally, however, the guides are not mechanically tied in which case there are d-c motors for each side and the position-tie is accomplished by means of a-c power selsyns. Two 25-hp, 650-rpm, d-c, motors on the side guides might, for example, be position-tied by two power selsyns rated 15 or 20 hp, 650 rpm. See Figures 23 and 24.

Side guides are normally adjusted by the operator according to the width of the strip being rolled. Side guides on the entering side of a reversing rougher should be set approximately one inch farther apart than the entering slab, while those on the delivery side must be moved out two or three inches more. As the mill reverses, the side guide settings change automatically with the entry guides moving in and the delivery guides moving out. This movement is known as the short stroke—which, of course, is superimposed upon the long stroke adjustment available to the operator in the mill pulpit. Side guides on the tables at the coilers also have long and short stroke operation—controlled by pushbuttons and pistol grip type control switches on the operator's desk.

Long and short stroke operation is obtained by means of rotating cam type limit switches electrically clutched to the drive. The short stroke is a forward-reverse positioning controlled by one of these limit switches. Long stroke operation is accomplished by declutching this short stroke limit switch and by-passing its circuit.

Where the duty is very intermittent with perhaps hours between adjustments, high torque squirrel cage induction motors can do the job very nicely. In fact, they are commonly used on the looper side guides located between the finishing stands.

ROUGHING MILL TABLES

Shunt or compound-wound motors may be used with reversing dynamic braking control on continuous hot strip roughing mill tables. Sometimes adjustable voltage control is applied since it lends flexibility of speed adjustment without sacrifice of motor torque. Normal operation is, of course, always in the forward direction.

On the front and back tables serving a reversing rougher, however, the requirements demand adjustable voltage-controlled shunt-wound motors. These must reverse rapidly with the mill and match mill speeds. Rotating type regulators are used to provide the necessary voltage regulating and current limit functions. It is standard practice to supply mill auxiliary type motors with generators designed particularly for this and blooming or slabbing mill type of reversing service. The motors are force-ventilated.

Much interest is currently being shown in the use of individual roller drives for heavy duty reversing tables, such as the live tables and the approach and

Figure 26 — Close-up shows finishing mill approach table motors. These are 7½-hp 600 series motors.

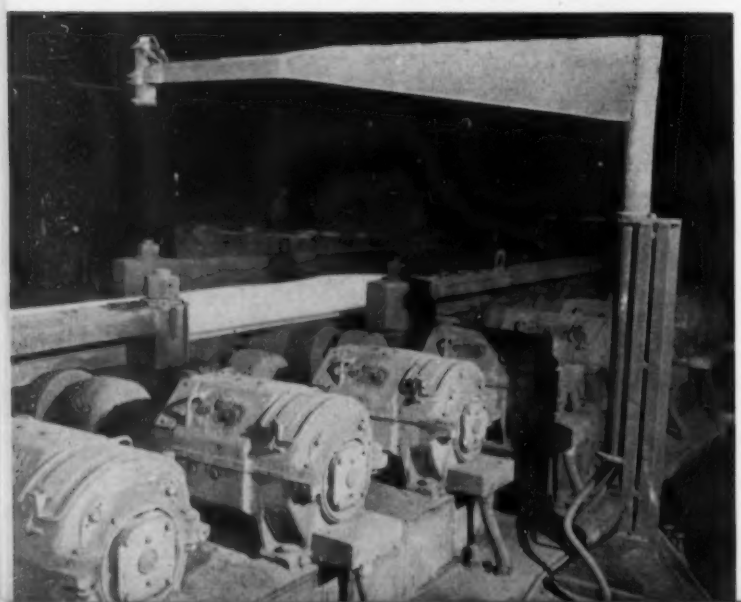


Figure 27 — Seventy motors drive the individual rolls on the finishing mill approach tables.

delivery tables of hot strip mill reversing roughers and large plate and slabbing mills. One installation utilizing 70 606 and 76 608 motors is in operation on a semi-continuous hot strip mill. Several installations exist on reversing mill feed rollers. A large plate mill will use 46 608 and 34 610 motors to drive individual table rollers. A large slabbing mill will use 34 618 motors to individually drive live table rollers and feed rollers.

All these drives consist of standard or semi-standard type mill motors operating at full torque, but at reduced horsepower and speed obtained by reduced armature voltage. It is, of course, desirable to keep the motor voltage reasonably high. For example for very low speeds this may be done by using the 550-volt motor and operating it at 250 volts or lower.

Figure 16, Part I of this article showed an installation of the adjustable voltage control panels, motor-generator sets and rotating regulator exciter sets for the tables and screwdown of a reversing rougher. For the schematic control diagram see Figure 14.

These so-called "live tables" on a reversing rougher may be controlled by their individual master switches in the operator's pulpit *and*, at the operator's discretion, can be electrically tied to the mill to reverse with the mill and run somewhere near mill speed. This speed tie may be accomplished in several ways. One is to take the table generator voltage control reference signal from a speed pilot generator on the mill, while another and more popular method is to tie directional and speed control points on to the mill master switch.

Between the roughing and finishing mills are the intermediate tables which may run continually but sometimes are called upon to stop and start with every strip thus assuming the role of "delay" tables. Adjustable voltage—controlled shunt-wound motors are the best choice in either group or individual drive arrangement. The rms duty is light, however, by comparison with that of reversing rougher tables. Force-ventilation is unnecessary if the motors are selected large enough to provide moderately high rates of acceleration and deceleration—say, three to four seconds for full speed range.

REVERSING ROUGHER SCREWDOWNS

Fast reversals, rapid raising and lowering, accurate spotting characterize the requirements of such a drive. Adjustable voltage controlled shunt wound motors are therefore the logical choice. When both screws are individually driven they are mechanically tied together by a d-c magnetic clutch which is opened for levelling when the screws are run in opposite directions. With single motor drives or with a common drive shaft, one of the screws is declutched and levelling accomplished by raising or lowering the other screw.

Magnetic brakes are included to aid in spotting and to help hold the screws stationary under the high rolling pressures.

CROP SHEARS

There may be one or two crop shears between the roughing mill and finishing train for cropping front and tail ends of the strip. Where two are used the one will

Figure 28 — Nearly all visible control devices on this reversing rougher operator's desk are for the auxiliaries such as: approach table; front, back and delivery tables; front, back, left and right side guides; screwdowns; position indicators for side guides; edger, etc. The mill is foot operated.

be located after the last roughing stand for cropping the front end of the strip. Two shears permit cropping of both ends with strip stationary on the delay table. Where only one shear is used, it is located just ahead of the finishing mill and suitable for cropping both ends, particularly the tail end, on the fly.

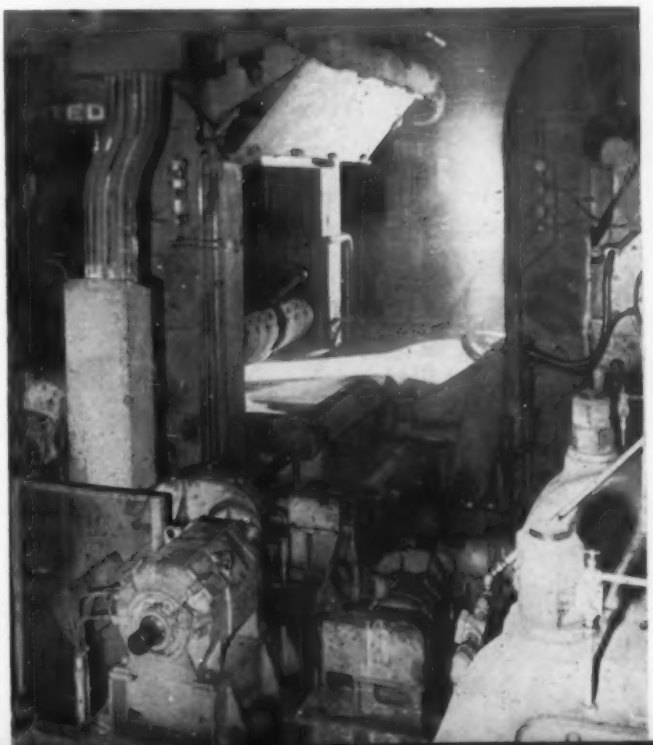
Constant potential controls are used on most crop shears; although some do have adjustable voltage.

A typical crop shear drive consists of a shunt-wound motor with reversing dynamic braking control, including a rotating cam type limit switch to cycle the operation, and a magnetic brake.

LOOPERS

Loopers are located between hot strip mill finishing stands to take up any slack that exists between the

Figure 29 — Looper on 86-in. hot strip mill.



stands. Without loopers there is a tendency for loose strip to double up and enter the following stand in a triple-thickness pleat cobbling the mill and damaging the rolls. By carefully observing the positions of the loopers, mill operators can roll with a minimum of tension between stands. On mills where the practice is to roll with some tension (strip straight and taut), the loopers are used as standby protection to aid in handling any loops which may arise as a result of incorrect drafting or stand speeds.

A typical looper drive consists of a torque motor (approximately 200 lb-ft torque rating) geared to a crank arm supporting an idler roll which bears upward against the strip. Looper arms rotate through about 50 degrees corresponding to several rotations of the motor which remains stalled as the strip passes through the mill. See Figure 29.

Standard mill auxiliary type motors are used. A 50 or 75-volt generator supplies power to all of the looper motors. Since the motors are stalled their armature currents will be directly proportional to the applied voltage. Hence it is possible to increase or decrease the torques of all the motors simultaneously by a rheostat in the generator field. Individual torque adjustments are made with rheostats in the motor field circuits. Sometimes the generator field rheostat is omitted, but rheostats for all the motor fields are always included and mounted in the operator's control pulpit.

Each looper has its own "On-Off" control switch on the control desk in the pulpit for manual operation. A "manual-automatic" selector switch is also provided there. When on "automatic" the operations are controlled by the stand load relays. As strip enters the mill, each looper will be energized by a signal from the load relay of the following stand; and as the tail end comes along the load relay of the preceding stand will de-energize the looper.

Loopers have been provided on all recent mills. However, because of the pressure for higher and ever higher tonnage and the increased possibility of cobbles when rolling without tension, there is a growing tendency to roll hot strip under tension and without the use of the loopers.

SCREWDOWNS — CONTINUOUS HOT STRIP MILL

Compound-wound or shunt-wound motors with reversing dynamic braking control are typical of practically all *continuous* hot strip mill screwdown drives, be they scalebreakers, roughing mill or finishing mill stands.

The required functions are: raise, lower and level. When both screws are individually driven they will have "duplex" control for the simultaneous control of the motors in the raise or lower direction, both being mechanically connected by a magnetic clutch. Levelling is accomplished by declutching and running the motors in opposite directions. Where a single motor drives both screws, the levelling is done by declutching one screw and raising or lowering the other. The finishing mill screwdowns are singled out for detailed discussion here.

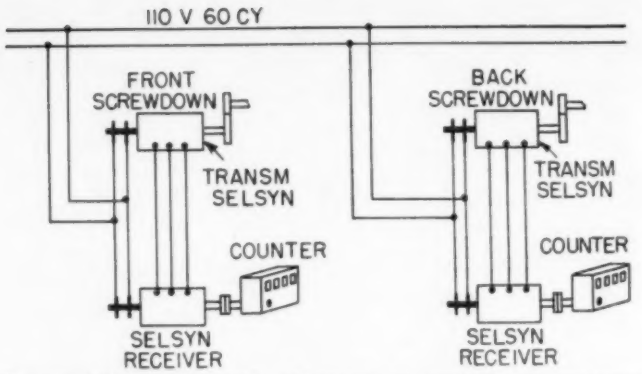


Figure 30 — Schematic diagram of typical screwdown position indicator.

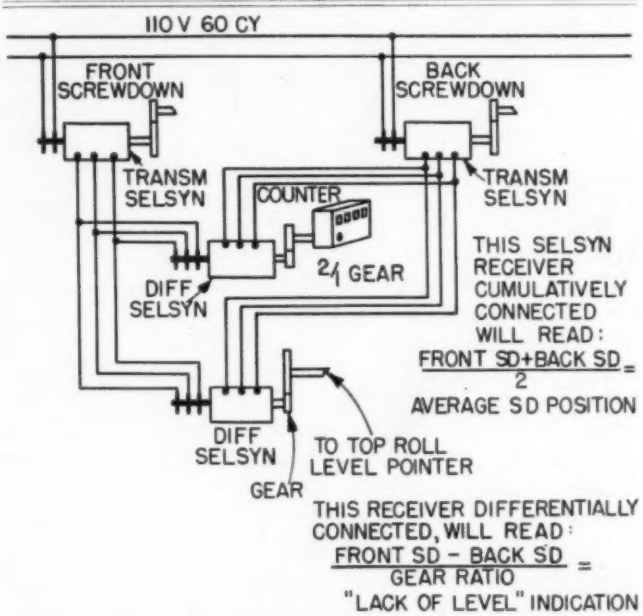

110 V 60 CY
FRONT SCREWDOWN
BACK SCREWDOWN
TRANSM SELSYN
TRANSM SELSYN
COUNTER
2/1 GEAR
DIFF SELSYN
THIS SELSYN RECEIVER CUMULATIVELY CONNECTED WILL READ:
FRONT SD+BACK SD / 2 = AVERAGE SD POSITION
DIFF SELSYN
GEAR
TO TOP ROLL LEVEL POINTER
THIS RECEIVER DIFFERENTIALLY CONNECTED, WILL READ:
FRONT SD - BACK SD / GEAR RATIO = "LACK OF LEVEL" INDICATION

Figure 31 — Schematic diagram of selsyn type screwdown position indicator with single counter shows average roll separation, and a selsyn-driven pointer shows lack of level of top roll.

Essentially, the electrical equipment for each finishing mill stand screwdown consists of:

Two 50 or 75-hp mill auxiliary type stabilized shunt-wound or compound-wound totally enclosed non-ventilated motors.

One magnetic clutch.

One magnetic brake (on some mills).

One reversing dynamic braking duplex type constant potential control providing the following functions:

a. Three speeds in the "raise and lower" direction, the top speed being obtained by motor field weakening, to be used when changing rolls, the first speed sometimes by "armature shunt" connection.
b. Levelling: "Up Front-Down Back" and "Down Front-Up Back."
c. Operator's controls in cabinet at mill stand and in the pulpit.

One selsyn driven screwdown position indicator system.

It will be noted that brakes are not always included. This is chiefly because a very high and consequently

a locking gear ratio is used thus making a brake unnecessary insofar as restraint of motion due to screw pressure is concerned. As for stopping the drive quickly, the dynamic braking seems to be fast enough if adjusted properly. By using the armature shunt connection on the first position of the control switch, accurate spotting of the screws is possible because the motors are turning over so slowly. Brakes should nevertheless improve spotting accuracy.

Special compound-wound motors are sometimes used. They are special in that the series windings are roughly half as strong as on standard motor. Such a motor retains to a substantial degree the high stalled torque of a standard compound-wound motor, yet it assumes some "adjustable speed" motor characteristics, permitting high speed operation by some considerable amount of field weakening, and at the same time excellent load sharing characteristics.

The conventional screwdown position indicator system consists essentially of two 110/55-volt, single-phase transmitter selsyns, gear-driven by the front and back screws, and electrically connected to two similar receiver selsyns coupled to mechanical counters mounted in the operators control box, together with the screwdown control switch. Figure 30 is a schematic diagram showing this arrangement. There are two electrically independent indicators; one for the front screw and one for the back screw. Both indicators should read the same when the top roll is absolutely level with respect to the bottom roll. There may at times be a substantial difference between screw settings, however, in order to keep the strip running straight as it leaves a mill stand. If one edge is hotter than the other, different screw settings will be required. The operator must then average the two readings to arrive at the so-called screw setting. To simplify determination of the average screw position (roll separation in the middle) the selsyn system schematically shown in Figure 31 was installed on a recent new mill. A single counter gives average roll position and a normally horizontal pointer shows how level the top roll is with respect to the bottom roll. Figure 32 shows one of the operators stand screwdown control boxes with these indicators.

Figure 32 — New selsyn type screwdown position indicator assembly is mounted on hot strip mill finishing stand housing. The receiver selsyns are of the differential type, each receiving signals from both front and back screwdown transmitter selsyns. Dial pointer shows any irregularities in screw settings; the counter gives the average (center line of mill) position of both screws.

1956 AISE SPRING CONFERENCE

April 30, May 1, 2

Lord Baltimore Hotel Baltimore, Md.

A NEW Approach to Continuous Mill Drives

By ASTOR L. THURMAN
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Mannesmann-Meer Engineering
and Construction Co., Inc.
Easton, Pa.
and
DIETER HANCKE
Mannesmann-Meer A.G.
M.-Gladbach,
Germany

. . . . a new mill drive incorporates a combination of a differential gear with a variable speed hydraulic unit for each stand with all stands driven by a common line shaft from the main motor . . . . drive can be adjusted to give any desired ratios of speed between consecutive stands of a continuous mill when running idle and also when running under heavy load . . . . drive is rigid after desired speed ratios have been obtained thus giving speed stability of a solidly geared mill . . . .

▲ EVENTS of recent years have thrown mill operators, machinery builders and electrical manufacturers into a fascinating race to build and operate more economical and higher speed continuous mills. Any kind of a continuous mill usually involves a major installation of machinery as well as electric equipment, and practically everyone connected with the steel industry has participated to some degree in these remarkable developments toward more accurate control, better drives and the resulting higher rolling speeds. Consequently any further development in this field should be of vital interest to all operating and engineering personnel throughout the metal working industry.

Certainly an indication of the wide reception given to new developments in this field, and the importance of this subject, is the broad coverage it receives in our industry's leading magazines. Almost every other issue contains some article or news item on the installation of spectacular new drives to modernize and speed-up an existing mill or a write-up on a complete new mill installation.

It therefore seems safe to assume that the vital facts which determine the layout of any given continuous mill drive are widely known. To bring these salient points to the fore, however, it should be worthwhile to list some of the important considerations which must be taken into account when making a new installation or when modernizing the drive of an existing mill.

Some of these points are:

1. Flexibility to meet widely different schedule requirements.
2. Handling ease for changing speed settings.
3. Fast response to speed control and, of course, sensitive and accurate control equipment.
4. Ability of the control to work automatically on any predetermined schedule, and to provide flexibility for changing speed ratios between successive roll stands to obtain changes in tension.
5. Most possible rigidity of drive after setting speed, thus maintaining constant speed ratios after they have been selected.
6. Easy maintenance and easy accessibility of drive components, and if possible, interchangeability of drive components such as motors, stand gear units and control parts pertaining to each stand.

When considering this subject with engineers it just is not possible not to admit that these different requirements, as usual, overrule each other, at least to some extent. How well the mill drive will finally work is therefore a question of how good a compromise it is possible to attain between the operating requirements, the technical possibilities and, last but by no means least, the financial considerations. Considering the final result, today's high speed continuous mills are really masterpieces of engineering.

In spite of all that was then known, however, when the engineers of Mannesmann-Meer in Germany started to build their first continuous rolling mill for hot reducing tubes and pipe under tension, or in other words a stretch reducing mill, they were not satisfied with what was known at that time about continuous mill drives.

Successful stretch reducing requires the possibility of achieving up to 90 per cent reductions with the tension values between successive roll stands of up to more than

80 per cent of the tensile strength of the material at rolling temperature, whereas it is understood that this tension has to be well under control to avoid overstretch of any cross section or breakage of the tube. The best method for keeping this tension under control is to make proper roll speed settings in accordance with all knowledge of the process itself, and then to use a drive which insures the maintenance of those selected speeds to the utmost degree.

Considering these requirements, the conventional method of driving each roll stand independently by an individual variable speed motor seemed to be insufficient in many respects. In order to avoid excessive speed drop of the motor when suddenly imposed to load, it must be greatly oversized compared to the required hp rating; on top of this, each motor has to be rated for the maximum possible continuous output of the stand it is to drive. Speed control to suit the required accuracy means that the motors must recover after the initial impact speed drop to the exact speed desired. Inasmuch as a very close stand spacing is one of the basic requirements for the economic application of stretch reducing, the time available for this speed recovery is very short. In fact, at one-foot stand spacing and 1000-fpm rolling speed, the recovery time permissible is less than 0.05 seconds. Furthermore, the narrow spacing of the stands makes it very difficult to fit the driving motors into the available space.

At this point it is well to mention that along with a new drive, a new engineering approach was made to the overall mill design, incorporating a three-roll per stand arrangement, and a mill frame to allow for an entirely new method of simple and fast stand changing. This arrangement differed considerably from all stretch mills previously built which were, in fact, conventional 2-roll type sinking mills with individual motor drives; in this case two rows of motors are installed along either side of the mill to solve the space problem. The new design called for one side of the mill to be fully accessible in order to bring in the roll stand changing equipment. This would have resulted in four rows of motors on one side of the mill, involving very intricate design problems in order to make the drive at all accessible.

Another choice for a drive arrangement was a common main motor with line shaft connection to each stand, as widely used on conventional sizing, sinking and reducing mills, but instead of the solid gearing using variable speed units for each stand. In general with practically all types of power units available, this drive would have many of the same disadvantages as those mentioned for the individual motor drive. As an example, fluid motors imposed to shock loads have a sizable speed drop, and although recent attempts have been made to allow for speed recovery of such hydraulic units, there is no need for this if the hydraulic gears are properly applied.

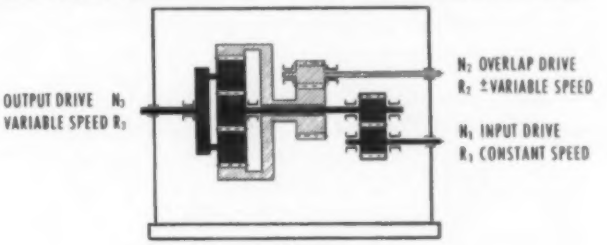
As an alternate to hydraulic variable speed units, similar mechanical drives have been investigated for use on continuous mills. The results, however, have not been very promising because of the limited load rating of mechanical speed variators, and the difficulties encountered in the proper governing of these units.

After a thorough study of the load, speed range, and accuracy requirements needed for high speed stretch-reducing, it was decided to introduce an entirely new drive principle. This new arrangement consists of the combination of a differential gear with a variable speed hydraulic unit for each stand, all stands driven by a common line shaft from the main motor.

The basic idea behind this combination is to limit the speed range of each stand unit to the actual requirements, thus imposing only partial loads on the variable speed units. Immediately this results in considerably less speed drop under full load, even to the point where the mill behaves practically as a solidly geared mill after the stand speeds have been selected.

Before going into further detail, it is well to outline briefly the background for these statements. In order to do this, it will be worthwhile to examine the two drive components and their characteristics.

Figure 1 shows a sketch of a differential gear unit similar to the ones used for continuous mill drives. The unit has two ingoing shafts, one of which is driven at a constant speed from the main drive. The other so-called



N_1 = INPUT DRIVE LOAD (HP)
N_2 = OVERLAP DRIVE LOAD (HP)
N_3 = OUTPUT DRIVE LOAD (HP)

R_1 = INPUT SPEED (RPM)
R_2 = OVERLAP SPEED (RPM)
R_3 = OUTPUT SPEED (RPM)

BASIC EQUATION FOR THE CONNECTION BETWEEN SPEED RANGE AND LOAD DISTRIBUTION

$$N_2 = N_3 \left(1 - \frac{R_{30}}{R_{31}}\right)$$

R_{30} = OVERLAP ZERO SPEED AT R_2 = ZERO
R_{31} = GIVEN OUTPUT SPEED

Figure 1 — Schematic diagram shows operation of differential gear.

overlap drive shaft must somehow be provided with a means of driving it in both directions of rotation at any speed between zero and plus or minus maximum. The output shaft is connected to the roll-drive, for instance to the pinion stand, and it generally drives through a speed reducer in order to take the heavy torques off of the differential unit.

The overlap drive share of this unit is the input shaft with its pinion, which in turn drives the cage of the differential gear through its meshing gear. The main power input is through its input shaft and pinion, which supplies the power to the center or driver gear of the planetary unit. The two follower gears which are meshed with the ring gear and the driver gear then run at the resultant speed to produce the power at the output shaft. The legend underneath the sketch explains the terminology with regard to horsepower loadings and shaft speeds.

The speed range-load distribution equation, $N_2 = N_3 (1 - \frac{R_{30}}{R_{31}})$, shows clearly that the load share of the overlap drive, N_2, at any given total output load, N_3, depends upon the deviation of the actual output speed, R_{31}, from the overlap zero speed R_{30}. At overlap zero speed, the overlap drive input shaft is held at zero speed. To illustrate the application of the speed range-load distribution equation, suppose for instance that the given output speed, R_{31}, is 30 per cent above over-

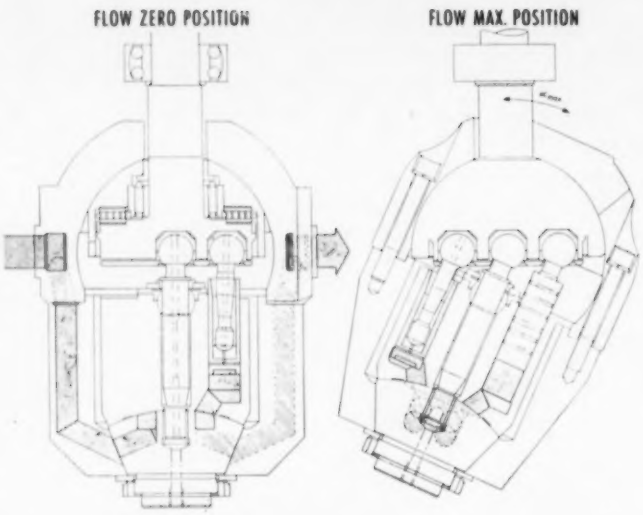


Figure 2 — Hydraulic units have been used in combination with differential gears in a wide range of applications.

lap zero, R_{30}; in this case the overlap drive supplies approximately 23 per cent of the total output power, N_3. If R_{31} is 20 per cent below overlap zero speed, the overlap loading approximates 25 per cent of the total N_3. If R_{31}, the actual output speed, happens to be at overlap zero speed, R_{30}, the overlap power share N_2 is also obviously zero; however, due to the peculiarities of the differential gear as an adding device, the torque at the overlap drive shaft does not vanish at zero speed. This somewhat undesirable fact has to be taken into account when selecting the type of variable speed unit to power the overlap input shaft.

The power share of the overlap drive at output below overlap zero speed, R_{30}, is not as unfavorable as it seems to appear at first glance. Generally at lower rolling speeds, the horsepower loading is correspondingly less, since the torque is usually constant. The fixed gear ratios inside the differential unit therefore provide the overlap drive with the same total horsepower as in the case of corresponding output speeds above overlap zero speed.

Incidentally, the gear ratio between the overlap drive shaft and the output shaft throughout the differential unit is of major importance for another very good reason. Suppose the overlap zero speed, R_{30}, is, for instance, 100 rpm, and the drive is operating at 130-rpm actual output speed, with an overlap speed of 1000 rpm at no load. Now if full load causes a drop in the overlap speed from 1000 to 980 rpm, or in other words of about 2 per cent, the actual output speed will drop from 130 to 129.4 rpm or only about 0.46 per cent. This fact assures rigidity of the new mill drive under suddenly applied load conditions.

The working principle of the hydraulic units used in combination with the differential gear is indicated by Figure 2. Pumps of this design have been used for over ten years in a wide range of applications. Among these are a large number of self-contained hydraulic presses, and other heavy mill machinery. With this operating history, there is no question about the dependability, performance and low maintainance of these units.

To give a brief description, these pump units are equipped with seven coaxially arranged pistons, which rotate with the pump cylinder around a king pin in the unit center. The piston rods and the king pin are connected to the drive flange by ball joints, thus allowing the complete pump cylinder to be swivelled out of unit centerline. The pressure against the pistons keeps the piston rods up into the ball sockets of the drive flange, and at the same time the pump pressure keeps the cylinder body down on the spherical surface of the counter bearing at the bottom of the unit. The cylinder body is rotated by the drive flange and the piston rods through contact with the pistons. With this construction and with all moving parts ground-in, no packing is required.

The hydraulic gear units applied to power the overlap drive shaft of the differential gear simply contain two pump units, one being driven as a pump and the other powered by the oil flow from the pump to act as a motor. The oil flows in a short circuit pipe line between the two units.

It is possible to vary the position of both units independently or simultaneously, thus either altering the oil delivery of the primary pump, which is being driven at a constant speed, or varying the speed of the secondary oil-motor. Since varying the oil delivery from the primary pump also results, of course, in a speed change of the secondary motor, various combinations of speed control are obtainable.

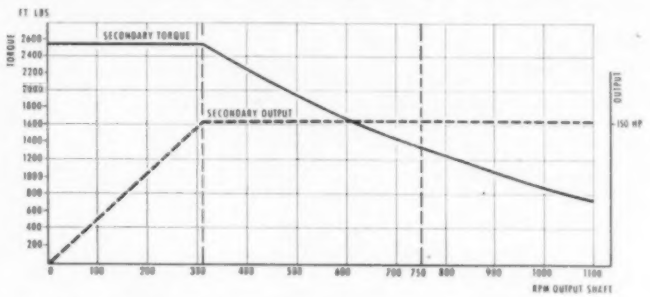


Figure 3 — Chart gives theoretical torque and output curves for a standard hydraulic gear unit.

Figure 3 shows the torque and horsepower output curves of a standard oil-hydraulic gear unit. The primary pump is driven at 750 rpm. The speed regulation below 750 rpm is effected by the primary pump only, while the secondary motor is held at the maximum angle. This results in a possible speed variation of the output shaft from zero to 750 rpm maximum in either direction of rotation, depending upon the position of the primary pump. Since the secondary motor is held at maximum angle up to 750 rpm, constant maximum torque is delivered by the output shaft throughout the entire speed range, the horsepower, of course, increasing from zero to maximum at 750 rpm.

Increasing the output speed above input speed requires that the secondary motor be swung in towards the zero flow position. Inasmuch as the delivery of the primary pump remains unchanged at the maximum value, the output speed increases to the permissible peak value, in this case up to 1100 rpm. In this range the torque and horsepower conditions are reversed; that is, the horsepower remains constant and the torque decreases with the position of the secondary motor.

It is obvious that with this combination, it is possible to maintain maximum torque on the output shaft at zero speed, the primary pump running at input speed

and — now being practical — in a position slightly off zero, just enough to cover the leakage losses of the system.

To cover this point, there are of course, some oil losses in the system, namely the oil used for lubricating the spherical bearing surfaces and the ball joints, as well as the slight oil leakage out of the cylinders between piston and cylinder walls; hence, there is a certain amount of slip between pump and motor, depending upon the pressure; this slip is caused by the oil leakage and by the compressibility of the oil in the cylinders, oil lines and especially in the circuit pipe line. The total amount of this slip, however, does not exceed 1¼ to 1½ per cent under the pressures used in mill drive applications.

An indication of the different losses is given in Figure 4. Note the volumetric efficiency, which indicates the total slip of the hydraulic gear unit. The mechanical and pressure losses combined with the volumetric loss make up the total losses to give a resulting efficiency which is quite high, even for a hydrostatic type variable speed unit.

Another operating characteristic is shown by the diagram of Figure 5. In this case the aim is to obtain a speed control which features constant horsepower over a wide speed range. Speeds up to 310 rpm are achieved by controlling the primary pump, thus delivering constant torque and increasing horsepower at the secondary motor shaft. From 310 to 1100 rpm, the secondary motor

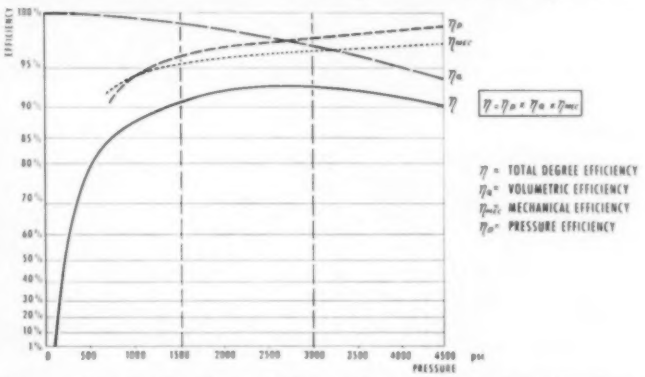


Figure 4 — Indication of the various losses of a standard hydraulic unit are given in this chart. Diagram is derived from test results.

is controlled at constant horsepower output up to maximum speed.

This diagram, together with Figure 3 is an indication of the versatility of this drive and the almost unlimited possibilities of this combination to match different requirements of speed control which may be required to meet given power and torque conditions.

The first mill equipped with this new drive was a 16-stand stretch reducing mill, installed at the Rath Works of Mannesmann in Germany, in combination with a high speed electric pipe welding mill. The idea of this combination was to weld large diameter pipe with standard walls, and to cover the entire pipe size range from 3 in. down to ½ in. by stretch reducing. The mill was furnished with 3-roll stands in order to achieve the maximum possible wall reduction, and to increase the quality of the finished product, all with a minimum number of stands. The maximum ingoing speed is 250 fpm to keep up with the pipe welder. Overall reductions up to 85 per cent have been made, the wall reductions reaching as high as 35 per cent.

The mill was furnished with 16 sets of overlap drives, connected by line shaft to a common a-c induction motor with a rating of 300 hp at 750 rpm. The mill went into operation in the spring of 1953 and has been in service ever since; however, many tests have been conducted to learn the exact characteristics of the new drive.

Figure 6 shows the drive scheme of this first mill with the new overlap drive. The speed cone indicated in the diagram covers the roll speed ranges necessary to match the desired rolling schedules. The center line of the speed cone is the overlap zero speed curve which is produced by the main drive through properly ratioed speed reducers between the differential gear output shaft and the rolls. The roll speed of each stand is variable through a range of ± 30 per cent above or below overlap zero speed by actuating the servo-motor for adjustment of the primary pump of the oil-hydraulic gear. Since each roll stand is equipped with its individual overlap set including pump servo adjusting motor, every possible speed curve within the cross-hatched speed limit lines is readily attainable.

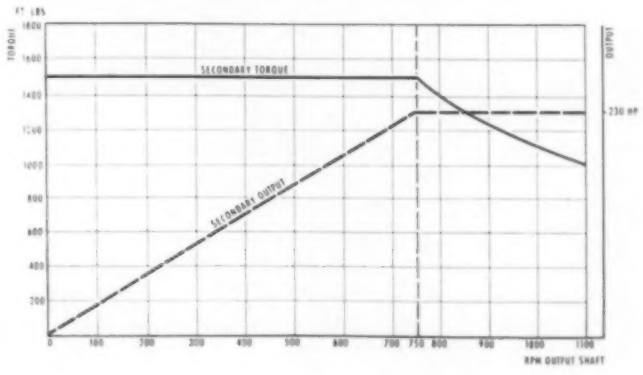
Furthermore it is possible to coactuate all pump adjusting motors by a common control. Since the gear ratios between the various pump servomotors and the pump adjusting mechanisms can be selected to suit rolling schedule requirements, for instance in steps of a geometrical progression, this would mean an equally distributed gain or decrease in intermediate roll speed ratios. Hence the mill operator is able to increase or decrease the overall elongation of the pipe going through the mill by actuating only one common control. Operators who have ever set up a stretch reducing mill for any program will agree that this is quite a help.

Another marked advantage of this hydraulic drive is the possibility of using pressure gages in the hydraulic circuits of the variable speed units. These meters are calibrated to indicate roll torque, thus enabling the mill operator to locate any trouble spot in the mill immediately and accurately; vice-versa the pressure meters are a delicate means of detecting any stand which may be out of step, as soon as the pipe is in the mill.

Figure 7 shows the structure of the mill drive for the scheme shown by Figure 6. Both the top shaft for driving the stand hydraulic gear unit and the bottom shaft going to the differential gear for one stand, are clearly visible.

A top view of the complete mill drive is given by

Figure 5 — Theoretical torque and output curves are given for a standard hydraulic gear unit.



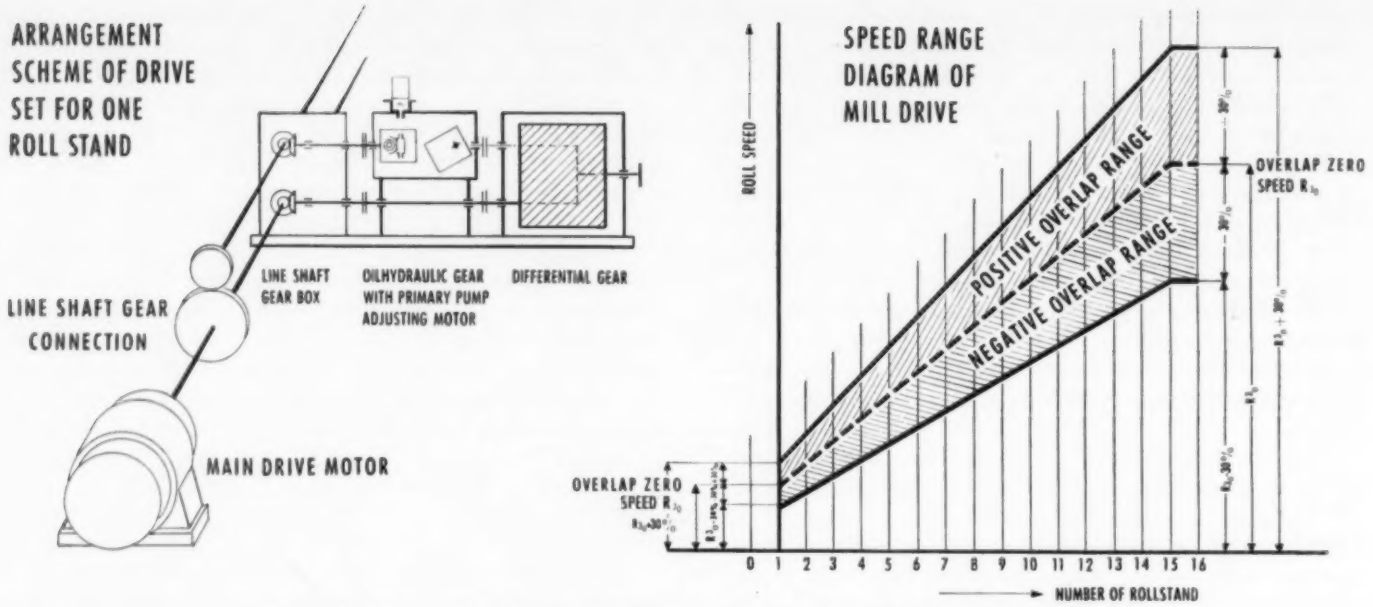


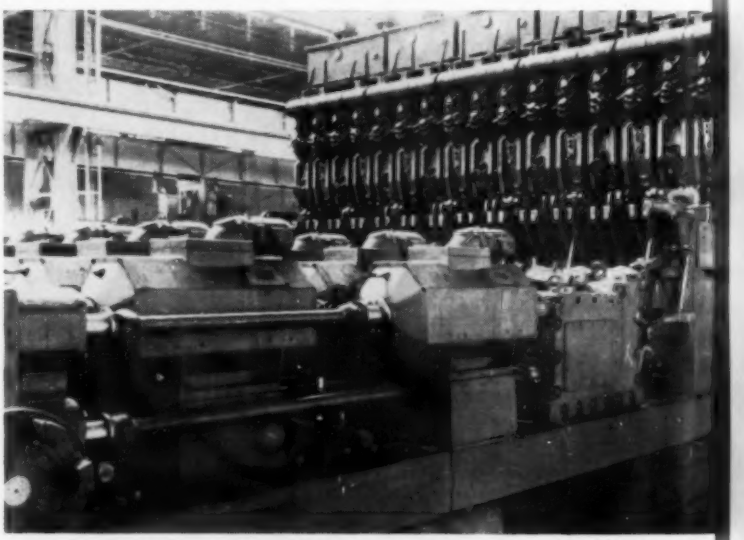
Figure 6 — Schematic diagram shows operation of stretch reducing mill drive.

Figure 8. The 16 differential gears at the bottom of the picture are shown connected to the rolls on the output side and to the hydraulic gears on the overlap input side; the constant speed input shafts are not visible. It was necessary to place the hydraulic overlap gears in two rows because of the close stand spacing of 10⅝ in. The primary pump adjusting motors are visible in the picture on top of the hydraulic units and the line shaft gearing with the main motor coupling are at the top of the picture. The oil cooler is located at the right corner. Both pump units inside the hydraulic gear box are completely submerged in oil to assure uniform cooling and to avoid any infiltration of air.

Figure 8 gives a good impression of the easy accessibility of the different drive components. After uncoupling the universal joints, every unit can easily be lifted out of its position and replaced by a spare unit. All differential gears as well as the hydraulic gear unit are interchangeable to allow for immediate replacement in case of mill trouble. Shear pin couplings at the outlet shafts of the differential gears protect the drive components against excessive overloads. A sticker in the mill can usually be removed simply by reversing the main motor.

The maintenance record for this mill on continuous duty indicates only about 3 per cent of the total pipe plant downtime due to the stretch mill.

Exhaustive tests of the mill in service have proven the outstanding rigidity of the new mill drive. The roll speeds of successive stands have been compared by means of a stroboscope, and the resulting speed differences were metered by use of a movie camera. Thus, stand for stand, through the mill, results were obtained for running idle, impact load when the pipe enters the mill, full load during rolling, peak load when the trailing heavy wall section of the pipe leaves the mill, and again at no load. Careful examination of the movies showed that the roll speed ratios between successive stands did not vary more than ¾ of one per cent for a condition of peak load on one stand and idle load on the next stand, and only a variation of 0.03 per cent for full load on both stands.



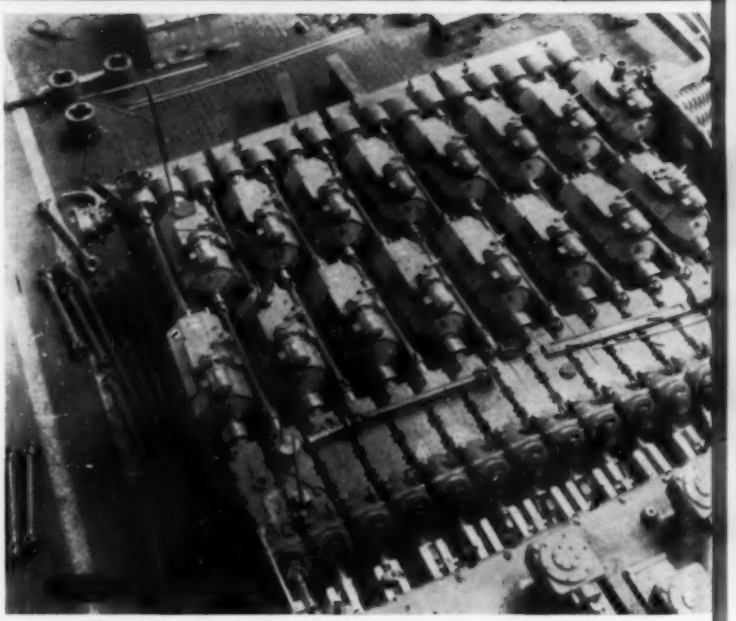


Figure 7 (top) — View shows an overlap drive for a tube mill. Figure 8 (bottom) — Overlap drive for tube mill has good accessibility.

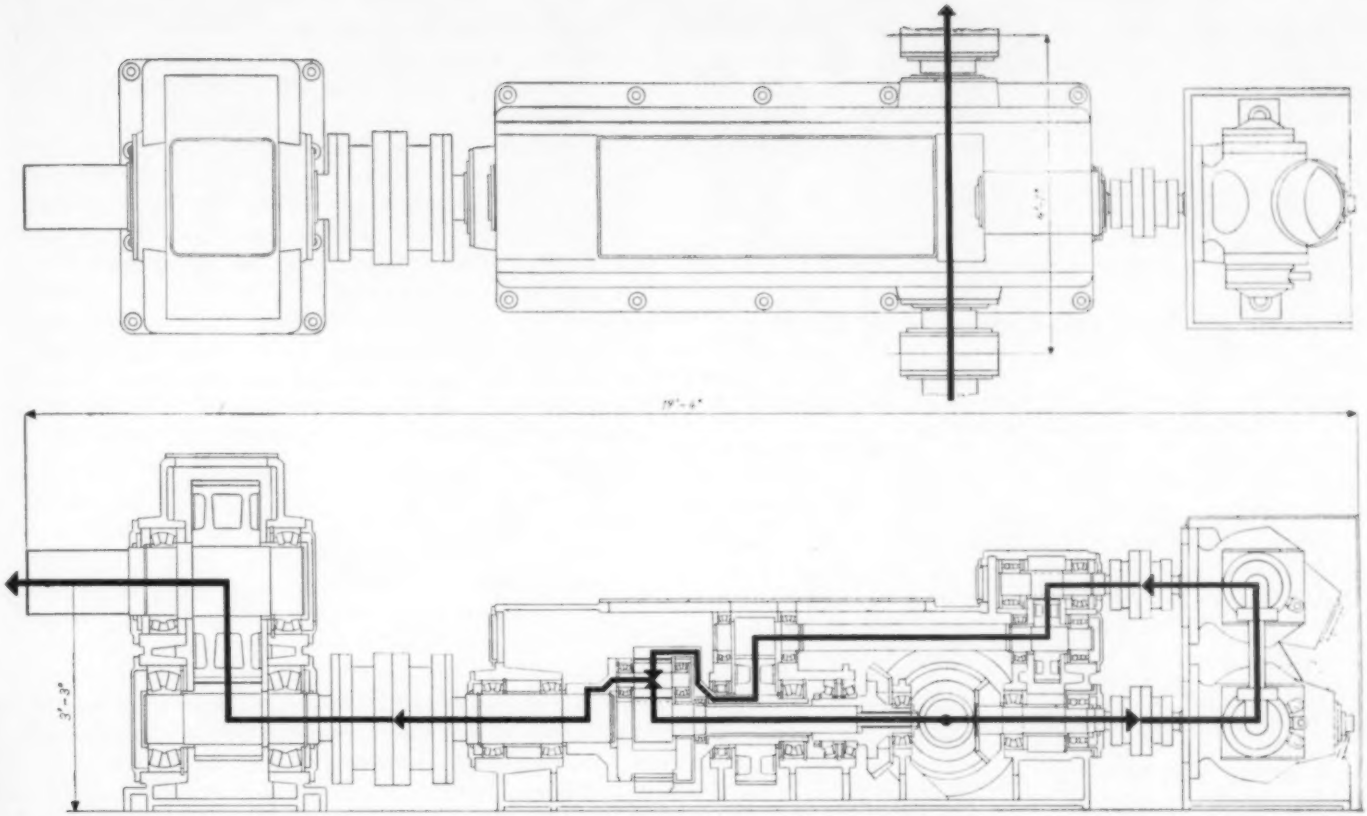


Figure 9 — Drawing shows the 550-hp overlap drive unit. Easily seen are the main drive line shaft differential gear, oil hydraulic gear unit and outlet speed reducer.

With such test results, the engineers were encouraged to make further applications of this new drive, but in view of these data, it was obvious that it would be necessary to develop a method of measuring speeds and speed differences which could meter to an accuracy to suit the speed behaviour of the new drive.

Ordinary tachometers fell short of the required accuracy; hence it was decided to apply a principle of metering speed differentials instead of actual speeds; this means that the speed differences between successive stands must be accurately produced and then measured by available standard instruments. This cuts down the possible errors to approximately 10 per cent, since the speed difference between successive stands is roughly one tenth of the absolute stand speed. With this type of indication, speed calculations must, of course, be based upon speed differentials instead of actual speeds.

Accurate indication of the speed difference between consecutive stands was obtained by using small differential gears to drive tachometer generators which would produce an output proportional to the speed difference, since both stand speeds were delivered into the differential gear. In order to eliminate any possible errors which might occur when using d-c tachometer generators, a-c generators were used to produce a frequency corresponding to the differential speed. This frequency could be measured with available standard instruments at a sufficiently high degree of accuracy, the speed meters, of course, being scaled in rpm differences. Recently a new differential speed metering setup has been developed which produces a differential frequency as an interference frequency of successive stand speeds directly, eliminating the need for the small metering differential gear.

A 550-hp overlap drive unit for one stand of a continuous tube mill is shown in Figure 9. This unit is designed for an output speed at overlap zero of approximately 100 rpm and a speed range of 1.5 to 1, spreading from 20 per cent below to 20 per cent above overlap zero, or, that is, from 80 rpm minimum to 120 rpm maximum. The main drive line shaft turns at 750 rpm main motor speed and transmits a total of 2500 hp at its motor coupling end. The various lines and arrows indicate the different gear components and their influence; the main line shaft drives through two bevel gears, one to supply power flow to the left to the driver gear of the planetary unit, the other to supply power to the hydraulic overlap drive unit to the right. The variable overlap speed flow goes through the two hydraulic units into the ring gear of the differential. The output is fed from the follower pinion through the gear reduction unit to the output shaft.

The hydraulic unit is freely accessible at the end of the drive for maintenance purposes and, also for best arrangement of the cooling and hydraulic piping for the pump units.

The overall arrangement of this stand drive is obviously dictated by the necessity of close stand spacing in the tube mill field. When more stand distance is permissible, the unit can be designed with shorter overall length. On the other hand, the requirement for low inertia on high speed mills which require quick response from the control, dictates a general design similar to the one shown on Figure 9. In fact, the only variable speed member rotating at high speed is the interior of the secondary pump with its shaft extension into the differential gear. As previously mentioned, the interior of the pump consists of the seven pistons with their piston

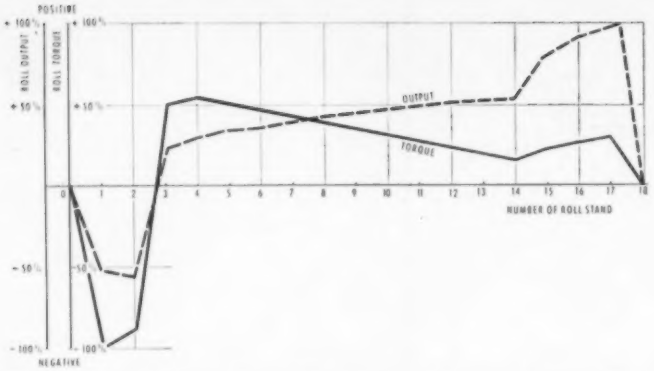


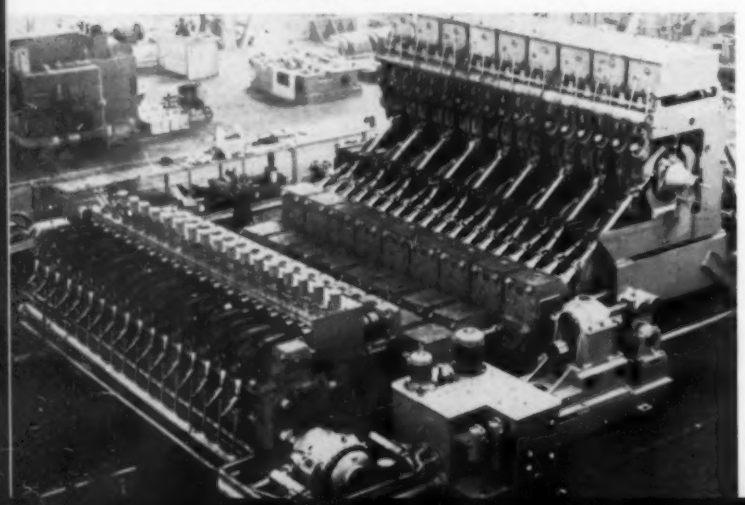
Figure 10 — Curves give roll torque and output curves on an 18-stand stretch reducing mill.

rods, the output flange and the inside pump body, which go to create a low inertia.

Another peculiarity of the new drive is worth mentioning. Figure 10 shows a load chart giving individual stand horsepower and torque for a certain rolling schedule on an 18-stand stretch mill. It is known that in stretch reducing the first stands are actually driven by the tube after it is in the mill; however, this is certainly not true when the tube enters the mill. In other words, at a certain time after the tube is in the mill, the roll torque on the first stands is reversed at the instant the tube enters one of the successive stands. Still the stand drive is supposed to show no response whatsoever to this treatment, and is expected to go on just as though nothing had happened. The hydraulic unit takes this beating in stride simply by reversing the load flow, putting the secondary oil-motor to work as a pump and the primary pump to work as a motor, this end of the unit being held at constant speed by the main drive.

These considerations, however, can be entirely opposite. Due to the torque conditions on a differential gear when producing an output speed below overlap zero, there would be a negative torque on the overlap input shaft. In other words, at idle speed the hydraulic unit works as a volumetrically controlled brake, holding the desired stand speed. When the pipe enters the stand, the hydraulic setup is in an instant thrown into negative shock load conditions, with negative torque on the overlap input shaft. Then as soon as the mill takes over, the pipe being in enough stands to produce the conditions indicated in the chart of Figure 10, the torque suddenly reverses to become positive.

Figure 11 — On this 18-stand tube mill equipped with an overlap drive, differential gears were placed in two rows alongside the mill.



Another principal advantage of this drive is that the complete inter-connection of the mill drive makes it possible to rate the main motor only to suit the horsepower needed for the actual rolling load plus the mechanical losses; this involves considerably lower total installed horsepower than would be possible with individual motors on each stand. Considering these facts and looking at the torque and horsepower curves of Figure 10, it is easy to see that each stand drive has to meet quite a number of different conditions.

This mill can work with fewer than 18 stands on rolling schedules requiring lower overall reductions. Moreover, the first stand does not necessarily have to be in the space for stand number one. The operating scheme is based upon using a standard set of roll passes ranging from maximum tube size at the entry end, down to the minimum tube size at the outgoing end, and especially upon using only the required number of stands in the mill.

A mill designed for this wide range of requirements is shown in Figure 11. The heavier load per stand required that the differential gears be placed in two rows alongside the mill, which is in contrast to the arrangement of the first mill mentioned. Another difference in this mill is that part of the speed range variation was taken out of the individual oil-hydraulic units and concentrated in one large hydraulic unit; therefore, the individual hydraulic units could be made smaller and thus arranged in one row near the main drive line shaft. The large secondary pump for this mill may be noted at the lower center of the picture. The primary pump is coupled to the double extension of the main motor shaft, and high pressure piping connects the two pumps.

Upon reviewing the basic requirements for today's continuous mill drives, this new overlap drive seems to be ideal for the application. The drive is practically solid as far as the maintenance of speed relationship between consecutive stands is concerned, after the desired speeds have been selected by the operator. The drive is able to respond almost instantaneously to any speed regulating means, because of the relatively low inertia of the high speed rotating parts. Speed control is extremely fast and is obtained efficiently by governing only the small pump adjusting motors. The control can be set up to perform any predetermined rolling cycle or speed schedule governed by such factors as tension or loops between stands. Both the flexibility of the drive and its handling ease are outstanding because of the possibility of introducing a co-adjustment to follow any given relationship for co-variation of all stand speeds. Maintenance is no longer a problem because of the exhaustive studies which have been made of the behavior, performance and life of the drive components under mill service conditions, and after improvements were incorporated as a result of these studies.

Hence it is now possible to build superbly performing hydraulic overlap drives for continuous multi-stand hot tube mills, strip, skelp, merchant, rod, bar or cold mills. A general drive scheme for such mills is shown by Figure 12. Speed regulation of strip mills is governed by the small adjusting motors in response to conventional control devices after idle stand speeds have been set by the mill operator. Tube and bar mills require close control of the tension and speed between consecutive roll stands by precalculating, preselecting and then rigidly

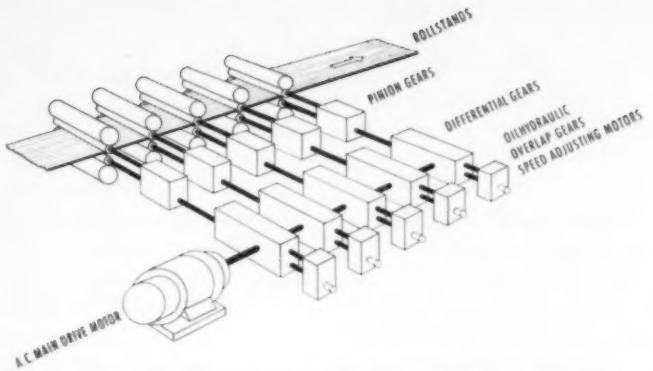


Figure 12 — Sketch shows drive scheme for multi-stand continuous hot and cold bar, strip, and tube mills.

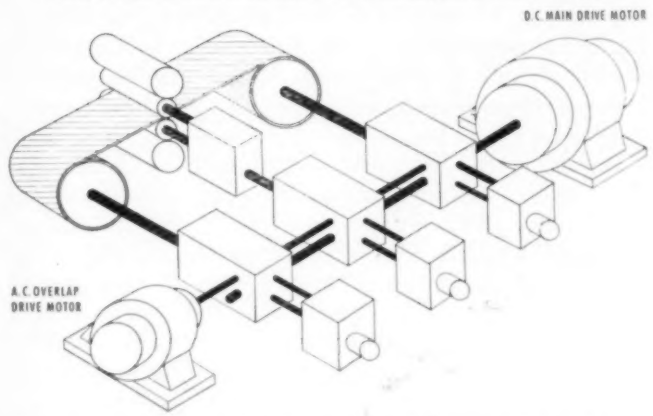


Figure 13 — Schematic diagram shows setup for drive on single-stand cold strip mill.

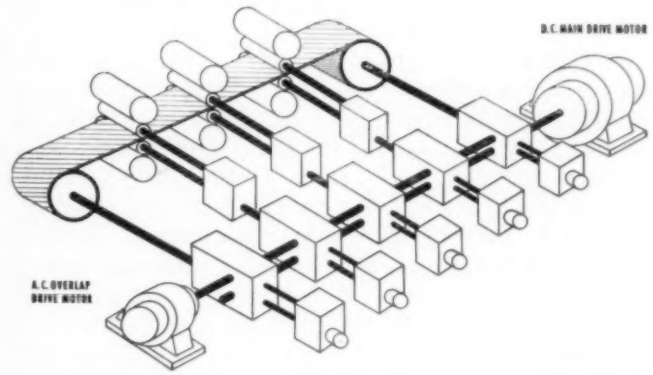


Figure 14 — Sketch shows drive scheme for multi-stand cold strip mill.

maintaining proper roll speeds; however, the mill operator can change any stand speed at any time to provide better rolling conditions, since he is precisely guided by the hydraulic torque meters and the speed differential meters. Speed coadjustment enables quick counteracting of changes in finished dimensions due to changes in overall operating conditions, such as, for instance, material temperature; vice-versa the coadjustment provides for easy and quick correction of incorrect assumptions in the preselected roll speeds, preventing unnecessary scrap losses.

Somewhat different requirements have to be met when providing this new overlap drive for cold strip mills with pay-off and tension reels; in this case it is not possible to have the mills running at full speed when the material enters the mill. Proper application of oil-hydraulic drive components, however, requires that the hydraulic units be up to speed before applying load, because of the peculiarity of hydraulic fluids, which produce best performance under stabilized starting conditions.

For this reason the oil-hydraulic units are separated from the main drive and are driven by a common a-c synchronous motor in order to eliminate any speed drop on the overlap drive input. The mill main drive is powered by a common d-c motor in order to provide for adjustable speed and the desired starting and stopping characteristics.

A drive scheme for a single stand cold strip mill with pay-off and tension reels is illustrated by Figure 13. The mill is ready to start with the main drive d-c motor stopped, the overlap drive a-c motor running and all primary pumps of the oil-hydraulic gears at zero position, without oil flow. After loading the coil onto the pay-off reel, the mill can be threaded by actuating the proper hydraulic units. When the strip has been threaded onto the recoiler, stalled tension can be applied simply by proper governing of the hydraulic units.

Now the d-c mill motor is started with the overlap drive control taking over immediately, thus producing exactly the desired starting speed characteristics by superseding the speed delivered by the d-c motor. In other words, at the start the differential gear output speed is slightly above zero speed, taking the power from the mill motor and leaving the accurate control to the hydraulic overlap units. The primary pump adjusting motors can be properly governed by known methods of tension and speed control.

The same principle applies when the mill is decelerated to rest. During the rolling operation, speed control of the roll drive and the reels is effected by the hydraulic overlap units in the same manner as previously described.

Figure 14 shows an overlap drive for a tandem cold mill. The drive is similar to the one for a single stand cold mill, except for the increased number of stand drive units. The operating principle of the drive is the same, with two separate main motors, one a-c and one d-c, for driving the oil-hydraulic units and the differential gears in the same manner as for the single stand mill.

To summarize, here is a new drive principle which should have a wide field of application, because this drive is adjustable in speed for obtaining any desired ratio between consecutive stands of a continuous mill both when running idle and when under heavy load, a drive which is rigid after these various speed ratios have been obtained, and again last but by no means least, a drive that is not too expensive. In other words, here is a drive at a nominal cost which can provide infinitely variable speed ratios between stands and still provide the speed stability of a solidly geared mill.

Furthermore, this outstanding advantage is gained without sacrifice of sensitivity of the drive units, in responding to varying speed requirements. By cutting down the size of the variable speed member to the minimum permissible value, determined by the mill operating requirements, a considerable decrease in inertia is obtained, hence making available extremely high speed response to control or regulation. This is possible because of the need to govern only the small pump adjusting servomotors; thus small, high accuracy, highly sensitive electronic speed control units can readily be applied to this drive.

Finally, it might also be considered that besides its

use for continuous mills, this new drive principle can also be considered as a variable speed unit for a wide range of conventional yet somewhat involved or delicate drive applications.

DISCUSSION

PRESENTED BY

CARL J. DEGENHARDT, Assistant Division Superintendent of Maintenance, United States Steel Corp., Munhall, Pa.

ASTOR L. THURMAN, Executive Vice President, Mannesmann-Meer Engineering and Construction Co., Inc., Easton, Pa.

WARREN C. THIRY, Sales Engineer, General Electric Co., Buffalo, N. Y.

W. B. SNYDER, Assistant Manager, Steel Mill Div., Industry Engineering Dept., General Electric Co., Schenectady, N. Y.

Carl J. Degenhardt: I would like to know, how could a drive of this type be protected in case of an overload on a mill which has no shear pins.

Astor L. Thurman: For a mill where it is not advisable to use shear pins, a pressure relief valve on the hydraulic system can be provided. This will give the overload protection desired.

Warren C. Thiry: What maximum oil pressure do you encounter in the two equipments that you have shown in the figures.

Astor L. Thurman: These units are designed for a maximum pressure of 6,000 psi, but for the best performance on most applications, the operating pressure is usually between 1,000 to 1,500 psi.

W. B. Snyder: The advent of a new mill drive is always interesting, and the one described by Mr. Thurman and Mr. Hancke is particularly so, as it appears to offer at least one feature not available in other forms. If I interpret the paper correctly, the drive consists of an adaptation of two well-known elements. Each stand is driven from a line shaft through a planetary gear, with input on the sun-gear shaft and output from the planetary cage shaft. The gear has the unusual feature of providing means of rotation of the ring gear in either direction, thus obtaining a differential action on the speed of the planetary cage. The ring gear is driven by a hydraulic pump, motor combination with the variable displacement motor driving the ring gear. The pump construction is similar to the "tilting plate" hydraulic drive, and by controlling the direction and amount of tilt, the hydraulic motor may be adjusted smoothly from maximum speed in one direction, through zero, to maximum speed in the other direction. The unusual feature here is a hydraulic drive of fairly large capacity, with high reliability and low maintenance. I trust the authors will forgive those of us who have had unfortunate experiences with hydraulic drives on hot strip mill flying shears for being a little skeptical and for wanting more definite proof of these features.

The behavior of the hydraulic drive is very similar to that of an adjustable speed direct current motor; Figure 4 in the paper shows a volumetric efficiency of about 98 per cent at half pressure scale, and about 94 per cent at full scale. Volumetric efficiency should be fully equivalent to motor speed drop with load, and assuming half scale corresponds to full load, the speed regulation is about 2 per cent, or practically the same as that of an unregulated d-c mill motor. The steady-state speed regulation of the motor can be greatly improved by the addition of modern speed regulating equipment, and the transient regulation can be somewhat improved by the same means. It should be noted that the planetary drive will be equally as effective in minimizing the results of electric motor speed regulation as it is in reducing the effect of hydraulic drive regulation.

The one feature in which I expect the hydraulic drive may have an advantage over the electric drive is in impact speed drop. When load is suddenly applied to a d-c motor, the armature current cannot rise instantly to the value required by the load due to the inductance of the armature circuit. Then, unless the mechanical inertias are such that the motor is "critically damped," the motor speed will drop to a value below that corresponding to the load, and then recover to the steady-state value, with perhaps a few oscillations about the final speed. In the hydraulic drive, the factors producing impact speed drop are the compressibility of the fluid and the expansion of the hydraulic channels, which will be negligible or very small. Therefore, the hydraulic drive should be well adapted to the tube stretch mills and similar drives where impact speed drop is a disadvantage.

The authors claim, with pardonable enthusiasm, the desirability of this new drive on all types of rolling mills, including large tandem hot and cold strip mills. Considering the fact that these mills may require from 20,000 to 30,000 hp, I would expect both the mechanical and the electrical problems imposed by a line-shaft drive to be almost insuperable, and I feel that these mills will continue to be driven by individual d-c motors. Furthermore, the tandem cold strip mill does not require the "stiffness" produced by the hydraulic drive, and in fact, too high a degree of stiffness is a disadvantage. Modern tandem cold mills provide an adjustable amount of speed regulation under the operators' control, and usually tapered with the least regulation on the delivery end. Such features would seem extremely difficult to provide on a hydraulic drive.

In conclusion, the drive discussed by Mr. Thurman and Mr. Hancke appears to provide very desirable features for mills where impact speed drop is harmful and where the drive capacity will lend itself to the construction described. It is to be hoped that the authors will have the opportunity to install a drive of this type at a place where the results can be observed, so that a final evaluation of its first cost, operating features and maintenance charges can be obtained.

Astor L. Thurman: Mr. Snyder's discussion was interesting and to the point. To answer his comments, the first to be mentioned is in connection with the hydraulic drive which has been used on hot strip flying shears. We are, of course, familiar with the past history of this application but I do not think it was your intention to compare this previous hydraulic unit with the new drive we have described. It should suffice for us to say that this new drive is based upon an altogether different design principle with the aim of overcoming the shortcomings of previous hydraulic drives, and that

the new drive has now been widely used with outstanding success.

In designing this unit we have also considered the use of electric motors for the overlap input speed. In the applications made to date, however, there has been a requirement for full torque at zero speed and for this reason the hydraulic unit has been preferred.

The success of several types of continuous mill drives is dependent upon a very low impact speed drop characteristic under suddenly applied load conditions. This is particularly true in the case of tube or pipe stretch reducing mills and continuous mandrel mills, and as Mr. Snyder has intimated, this new drive is especially well suited for this requirement.

Mr. Snyder has questioned the application of this new drive principle to large tandem hot and cold strip mills. In presenting our paper it was merely the intention to show how this drive could be applied to different types of mills, but so far we are talking in terms of an individual stand output of about 1,000 hp, and certainly we do not yet want to suggest this drive for a mill requiring anywhere near 20,000 hp. The metal working industry owes a great deal of thanks to the electrical industry for the contributions it has made toward the success of these high speed mills, and we do not in any way intend to detract from the importance of the electrical industry in this continued progress. On the other hand, however, this new drive combination is capable of meeting the unusual operating requirements of many smaller drives. A careful study of the application is, of course, always in order before making the final selection of any type of drive. It is expected that several new hydraulic-differential drive combinations will soon be installed in this country for different applications, which will provide the best opportunity for a real appraisal of these drive units in the steel industry.

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By K. S. KUKA, Assistant Chief Engineer (Electrical), Tata Iron and Steel Co., Ltd., Jamshedpur, India

A Stabilized D-C Crane Hoist Control

. . . . there are a number of types of crane hoist control circuits used in normal steel plant service, each of which has special features . . . . a new circuit described in this paper provides relays for each critical function so interconnected that failure to function properly in sequence should have no serious effect on the crane operation . . . .

▲ DIRECT-CURRENT crane hoist control systems have been fairly well established and most well known control manufacturers have their own standard control schemes tried out over a number of years. During recent years, however, several new control schemes have been developed, which have replaced the older well established hoist control circuits which were long accepted by the steel industry. The major emphasis has been laid on the motor current circuit to obtain more stable speed-torque curves. The object has been to limit the main circuit contactors to nine, and obtain five speed-torque curves, both for hoist and lowering, such that distinct speeds are obtained for each master switch step from no-load to an overload up to 200 per cent of the crane rated load, without the curves showing a tendency to overlap one another. Each master switch step establishes a stable speed point without any overshoot, irrespective as to how erratically the switch handle is moved.

Few control schemes however provide automatic protection against heavy current peaks, or sudden overspeeding due to failures of contactors or relays to function in proper sequence.

Steel mill cranes have to operate under very severe conditions, as a steelman usually expects his cranes to help him out even for most abnormal duties such as, skulling a hot metal ladle or removing a metal jam or pulling loaded cars.

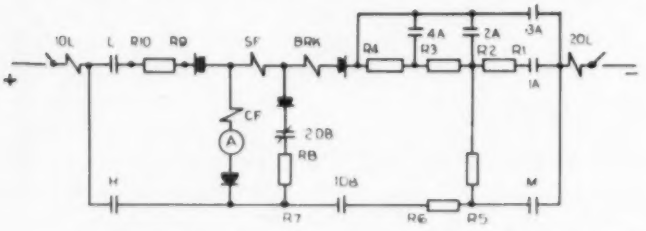
Occasionally, serious accidents do occur on steel plant cranes due to sudden failures of a contactor, a relay, a resistor or an overhoist limit-switch. An electrical maintenance man therefore expects that the electrical circuits be so designed, that the control would be self-protective against dangerous overspeeding, or heavy short-circuit current peaks, or transient voltage and torque peaks which may overstress other vital sections of the crane.

The burning of the contacts of the motor-power-circuit contactors is also a major problem of maintenance, so that the design of the main motor circuit also becomes of vital importance. If the power circuit is so designed that four or five contactors in series are required to carry full load current most of the time, the heating and wear on the contacts will be increased, and the chances of freezing and sticking of the contacts will be enhanced.

This paper describes a modified hoist control circuit which has been designed to minimize the problems of maintenance and transient dangerous conditions created by the electrical-circuit faults under actual operations, or caused by unrestrained erratic movements of the master switch by the crane operator.

Figure 1 gives an elementary diagram for the motor power circuit with the values of control resistances expressed in per-unit quantities. The circuit is almost the same as for a standard controller, both during "hoist" and "lower". The circuit is however made more simplified and straightforward. The method of chang-

Figure 1 — Elementary diagram for main motor circuit shows contact closing sequence and resistance steps.



CONTACTOR SEQUENCE

× DENOTES CONTACTS CLOSED

CONTACTS	L 5	L 4	L 3	L 2	L 1	OFF	H 1	H 2	H 3	H 4	H 5
H							×	×	×	×	×
L	×	×	×	×	×		×				
10B	×	×	×	×	×						
20B					×	×					
M	×	×	×	×					×	×	×
1A				×	×		×	×	×	×	×
2A			×	×	×					×	×
3A											×
4A		×	×	×	×	×	×	×	×	×	×

NOMENCLATURE

A	MOTOR ARMATURE
CF	COMMUTATING FIELD
SF	SERIES FIELD
BRK	SERIES BRAKE
OL	OVERLOAD RELAY
H-10B	MECHANICALLY INTERLOCKED
L-3A	" "
	TROLLEY CROSS BAR COLLECTOR
	NORMALLY OPEN CONTACTS
	" CLOSED "

RESISTANCES IN PER UNIT OHM

$R_1 - R_2 = 0.4$

$R_2 - R_3 = 0.3$

$R_3 - R_4 = 0.8$

$R_2 - R_5 = 0.5$

$R_5 - R_6 = 0.15$ Adjustable 0.1 - 0.15

$R_7 - R_8 = 0.6$

$R_9 - R_{10} = 0.5$ Adjustable 0.4 - 0.5

OPEN PER UNIT ohm = $\frac{\text{MOTOR RATED VOLTS}}{\text{MOTOR RATED AMPS}}$

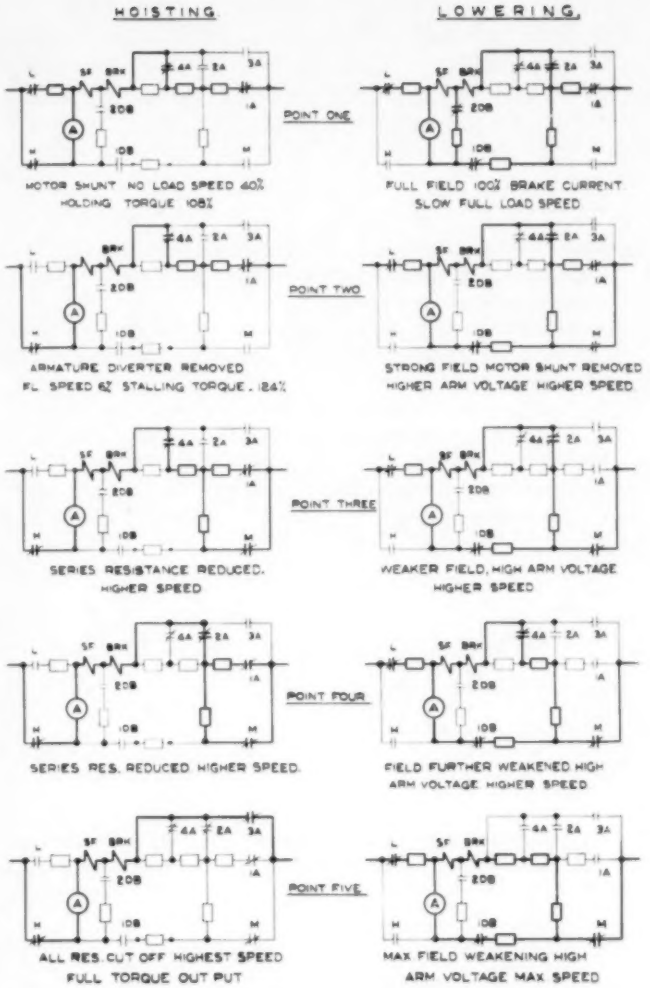


Figure 2 — Schematic point-by-point power circuit connections are shown. Thick lines denote parts of the circuit which carry current at each point.

ing the direction of rotation is by the motor armature reversals. The changeover from the motoring action to the dynamic braking action is automatic, depending on the crane hook load.

Figure 2 indicates the step-by-step power circuit connections, with thick-lines indicating the paths through which the currents flow on each master switch point. The major features of the power-circuit are:

1. Nine contactors and seven resistance steps give five distinct speed-torque curves, both for "hoist" and "lower" directions.
2. Contactor sequences are so arranged that the accelerating contactors are relieved of their currents in sequence, both during "lower" as well as "hoist" cycles. During the "hoist" cycle, only the contacts H and 3A carry the motor full-load current on the last point of the master switch, while the contact H alone carry the motor current continuously throughout the cycle. This major feature must increase the life of the accelerating contacts to a great extent.
3. A contactor is actuated only once, either energized or deenergized, in a complete movement of the master switch in any one direction.
4. During the "lower" sequence, all the resistance steps become effective in the last point, so that the possibility of overspeeding due to failure of any accelerating contactor is eliminated.

SPEED-TORQUE CURVES

Figure 3 gives the calculated speed-torque curves for each master switch point, where the motor armature reaction is also taken into account.

The specific features of the speed-torque characteristics are as follows:

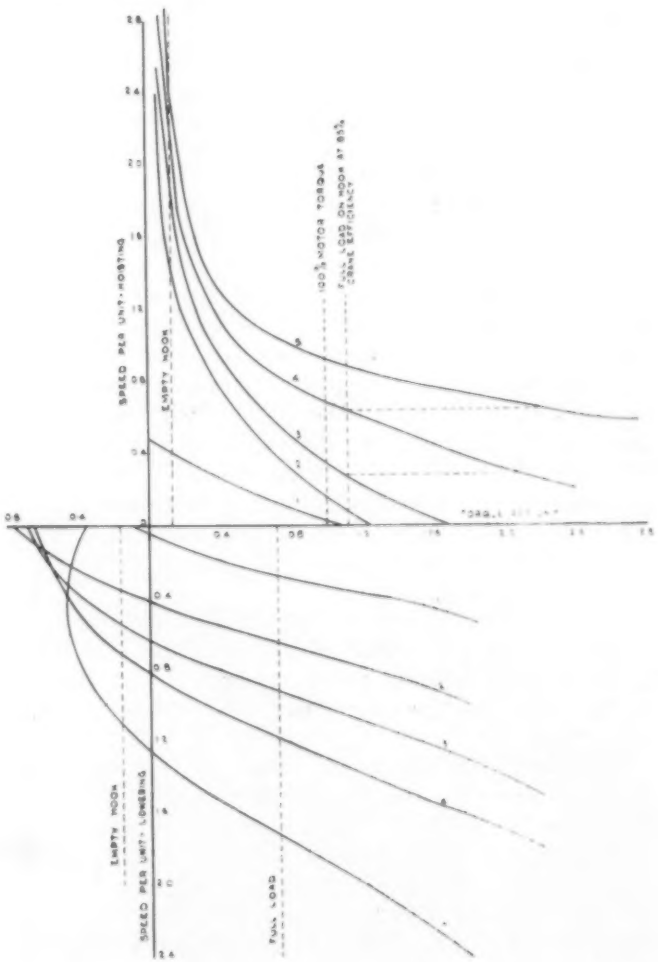
1. "*Hoist*" *characteristics* — The first curve limits speed between 0 and 48 per cent. The crane rated full-load is hoisted at a creeping-speed for an efficient crane with ball and roller bearings. For a crane with an efficiency of 85 per cent, a stalling-torque is provided up to about 125 per cent of full-load. The speed with no-load on the crane-hook is held to within 40 per cent of the full-load normal hoisting speed.

The first point speed-torque characteristic thus permits a load up to 125 per cent to be held without any downward drift, while a slack cable can be smoothly taken over, without any jerking during engaging of a hook to a load.

For raising "hoist" speeds, each master switch point gives a smoothly-accelerating higher speed in regulated steps, which gives a fairly fast acceleration for rapid lifting of heavy loads.

2. "*Lower*" *characteristics* — The first curve is mainly provided for spotting of the loads from light-load to an overload, the full-load lowering speed being limited to 30 per cent. The lowering speeds from no-load to full-load are obtained in distinct steps. The droop of the

Figure 3 — Speed-torque characteristics are given for the hoist controller.



curve for each step from no-load to full-load is almost equal, as the curves run approximately parallel to one another, the acceleration on each step being almost constant from no-load to heavy overloads.

For 200 per cent rated load which requires a motor countertorque of about 145 per cent for an 85 per cent crane efficiency, the maximum speed is 215 per cent of the full load hoist speed. The maximum motor stability for any possible overload that the crane is capable of carrying is thus fully ensured.

The control is designed for a no-load-lowering speed of about 120 per cent of the normal-hoisting speed. If faster no load speeds are desired, an additional field-weakening resistance-step, controlled over a spring-closed contactor and a differential relay, during the lowering of light loads can be added as a special feature.

OVERHOIST LIMIT SWITCH

Power-type, series-connected, overhoist limit switches connected to the motor power circuit have long been standardized for steel plant cranes. These limit-switches are essential to prevent overhoisting of the crane-hook-block.

1. *Conditions of hoisting with limit switch tripped*— Figure 4 shows the relevant power-circuit connections in the "hoist" direction with the limit switch in tripped position, from the master switch second-point onwards. When the limit switch trips with the overhoisting of the crane-hook-block, the limit switch contacts 1LS and 2LS open, and the contacts 3LS and 4LS close. The motor gets disconnected from the power lines over the contacts, 1LS, while the motor armature and the motor series field get reconnected over the contacts 3LS and 4LS to form a closed-loop over the resistance R13-R14. In case the crane hook is overhoisted at a high speed, the loop circuit over the contacts 3LS and 4LS gives a high regenerative braking motor torque to slow down the motion, which assists the deenergized electro-mechanical brake to hold the motion to a rapid standstill. If there is no dynamic braking circuit provided over the limit switch, an unloaded-hook when overhoisted into the limit switch at about 225 per cent speed, will move about 80 per cent higher up before the mechanical brake brings the motion to a standstill. This may result in the hook running into the rope drum and breaking the rope, unless the limit switch zone is proportionately increased to take care of the extra travel of the hook. Accidents do occur due to such careless overhoisting of crane-hooks, and it is essential that particular attention is given to this condition, when no-load hoisting speeds above 200 per cent of the full-load speed are encountered.

It is desirable therefore that the control scheme is designed to give a circuit which would provide sufficient dynamic braking torque against a fast moving hook, every time the master switch is returned to first point "hoist".

Figure 5 gives the relevant motor-power-circuit connections when the master switch is retained on the first-point "hoist" with the limit switch tripped due to over-hoisting of the hook block. It will be observed from Figure 5, that the circuit provides a plugging torque, because the motor armature connections are automatically reversed over the limit switch contacts. This brings

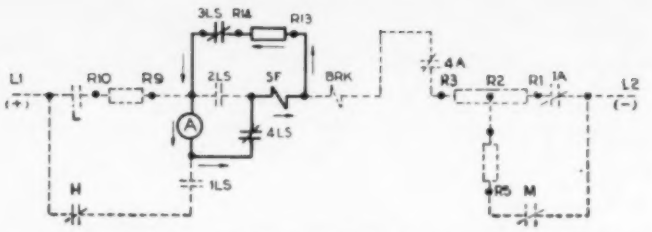


Figure 4 — Diagram gives main circuit connections during hoisting from second point onward with overhoisting power limit switch tripped.

1LS-2LS — Limit switch contacts closed during normal operation which open when limit switch trips.

3LS-4LS — Limit switch contacts open under normal operation which close when limit switch trips.

R13-R14 — Resistance step providing automatic dynamic braking action when limit switch trips due to overhoisting.

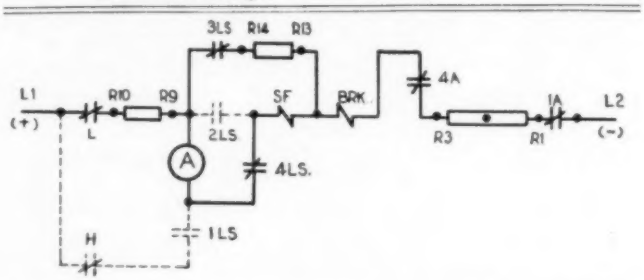


Figure 5 — Main circuit connections on first point hoist with overhoist power limit switch tripped are given.

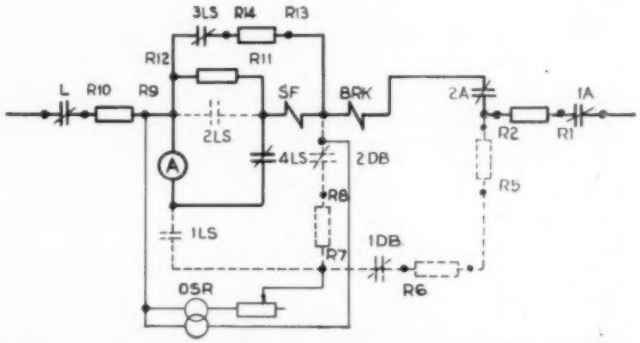


Figure 6 — Main circuit connections on first point lower with power limit switch tripped are given in the diagram.

R11-R12 — Resistance step to provide automatic dynamic braking action to lower a load at slow speed with power limit switch tripped.

OSR — Overspeed relay to automatically disconnect the motor from the line if load accelerates beyond a certain speed if lowered with power limit switch tripped.

the motion to a rapid stop, which would then start to lower the hook. Referring to the Figure 4 first-point "hoist" curve, it is observed that the motion is rapidly brought down to about 40 per cent speed, as the circuit provides a heavy dynamic-braking-action against a fast moving hook.

If the crane operator is careful to pause at the first point of the master switch when trying to stop the hoisting motion, it will be practically impossible for the crane-hook to run into the hoist rope drum even on cranes where light hook speeds of 250 per cent and higher are attained.

2. *Conditions of lowering with limit switch tripped* — A crane hoist circuit should be capable of automatically resetting the limit switch to its normal position, if it is tripped by overhoisting. This is done by turning the master switch handle to "lower" position.

Figure 6 gives the power-circuit connections with the limit switch in tripped position and the master switch on first point "lower". The motor-armature and the motor series field get connected in series over the limit switch contacts 3LS, which provides the "lower" directional power circuit to the motor. The resistance R13-R14 provides a motor diverter connection over the limit switch contacts 4LS, which determines the voltage across the motor and limits the speed, while a light hook is handled to reset the limit switch. The motor torque developed is sufficient to automatically lower a light hook at a slow speed until the limit switch resets by itself. The brake operates easily as all the line current flows through the brake coil because of its very low resistance. This is shown by thick lines in Figure 6.

If, however, an attempt is made to rest the limit switch from tripped position with an overhauling load on the hook block, the power circuit does not permit automatic dynamic braking action of the motor and the load tends to race downwards as the brake releases. This dangerous condition which obtains with all standard hoist control schemes with power type limit switches has been the cause of several serious crane accidents.

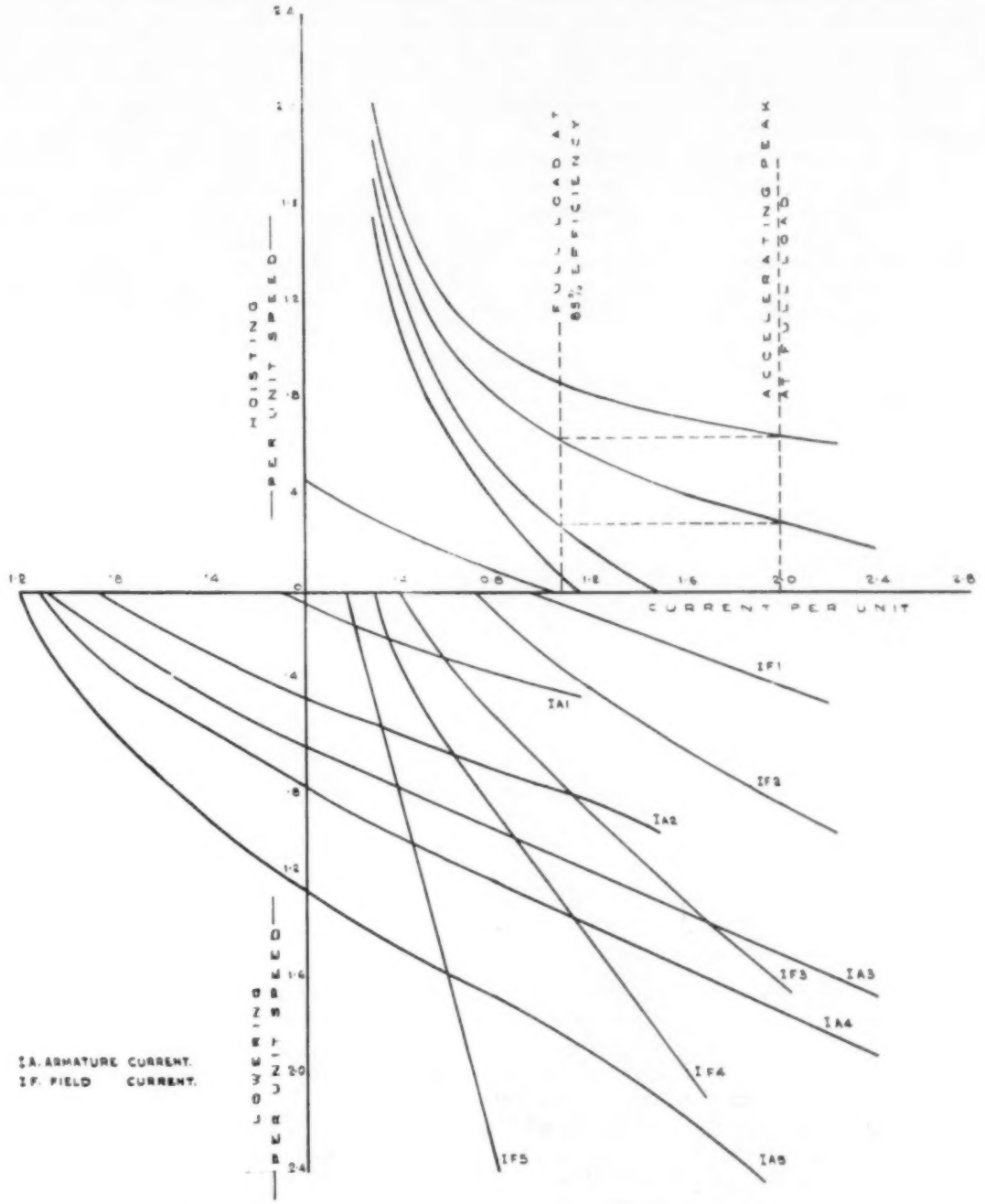


Figure 7 — Speed-current characteristics of hoist controller.

To provide an automatic protection against such an over-speed condition, a resistance step R11-R12 can be provided as shown in Figure 6, which is introduced into the circuit when the limit switch contacts 2LS open in the tripped position. Resistance R11-R12 automatically gets connected as a motor armature diverter which provides dynamic braking action to control the speed while resetting the limit-switch with an overhauling load. For normal operations, the resistance step R11-R12 is short-circuited over the contacts 2LS which remain closed.

The introduction of the limit switch resistance R11-R12 gives a safe protection against runaway conditions

when an attempt is made to lower a load with the tripped hoist limit switch. The main objection against the provision of such an additional resistance is that it has to be installed on the crane trolley, where it is difficult to find space and where it is likely to remain unattended.

In Figure 6 is also indicated a relay OSR, which is especially provided in the circuit. The function of this relay is to give protection to the crane against runaway overspeed conditions due to failure of motor dynamic braking action. The relay OSR is described later. This relay makes the addition of the resistance R11-R12 unnecessary.

A d-c mill type motor which is normally used on steel-mill cranes is a well-designed robust machine, which is capable of a good deal of rough punishment. The modern mill type d-c motor can safely commutate 300 per cent of its full-load, one-hour rated current. For crane hoist service, the motor is operated on the basis of its half-hour rating, which is about 33 per cent higher than the one-hour assigned rating of the motor. The crane motor is protected by over current relays set at 250 per cent of the half-hour rated full load current. The control is designed to maintain the maximum current peaks to within 225 per cent of the motor crane duty rating, while the overload relays are set to trip off instantaneously at 250 per cent current.

Figure 7 gives the calculated values of the motor armature currents as well as the motor series field currents corresponding to the speed-torque curves of Figure 3.

Figure 8 gives the armature internal-voltages generated across the commutator brushes during the "lower" sequence, corresponding to the currents in Figure 7.

Referring to Figure 7, it is observed that the maximum accelerating peak current with full load hoisting does not exceed 180 per cent of the motor rated current. The hoist control thus permits 110 per cent rated crane load to be hoisted without exceeding 225 per cent current peaks even when the master switch is suddenly thrown to its final maximum speed position. If loads heavier than 110 per cent are required to be handled, it is desirable to use slower speed points on the master switch.

Referring again to Figure 7, it is observed that while lowering, 120 per cent rated crane load attains about 180 per cent speed, and the motor develops a dynamic braking torque of about 86 per cent of the rated full load hoisting torque.

While 120 per cent load is being lowered at 180 per cent speed, if the master switch handle is suddenly moved to "off" position, the control is so designed that the motion is transferred from speed-torque curve 5 to curve 4. At this point, the operation is automatically delayed for about 0.3 second for the conditions to stabilize on curve 4, before the motor is disconnected and the dynamic braking contacts 2DB close.

When contactor 4A closes, the lowering speed with full-load is still at 180 per cent. Closing of contacts 4A strengthens the motor-field by the short circuiting of the field weakening resistance step R3-R4, which produces a transient torque peak of about 225 per cent, which decelerates the load to about 120 per cent speed corresponding to the stable speed for 120 per cent load on the speed-torque curve 4. The corresponding transient current peak is about 215 per cent and the voltage peak is about 175 per cent.

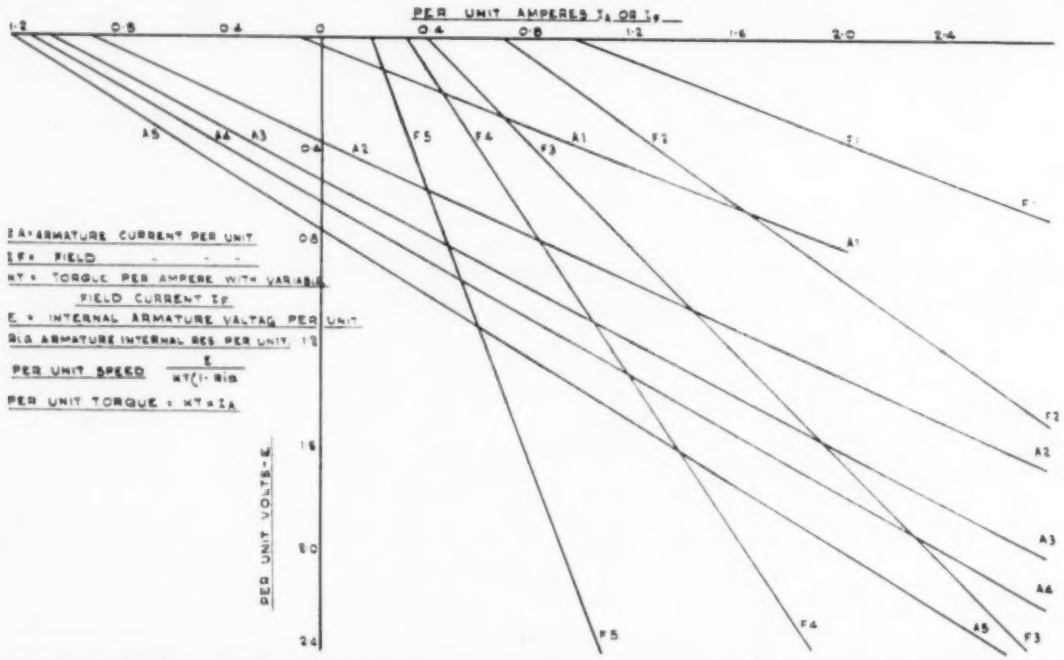


Figure 8 — Curves show relationship between armature current I_a field current I_f and voltage during lowering cycle.

At the time when the "off" point dynamic-braking contactor 2DB gets deenergized and contacts 2DB close, the speed will still be about 120 per cent which was the stable lowering speed on curve 4. At that point, the motor is disconnected from the power lines and an electrically closed circuit is applied over the contacts 2DB and the resistance R7-R8. The motor with its armature still rotating at about 120 per cent speed then becomes a self-excited series generator. The second transient current-peak at the moment the contacts 2DB close, is about 200 per cent with a voltage peak of about 120 per cent and a torque peak of about 240 per cent.

The control circuit thus limits the maximum simultaneous peaks to 215 per cent current and 175 per cent voltage. The maximum torque peak is limited to 240 per cent.

BASIC PROTECTIVE FEATURES

Figure 9 presents the complete crane hoist control scheme, indicating the power circuit, the control circuit and the master switch connections, with the power type overhoist limit switch. Besides the nine power circuit contactors and the usual two overcurrent relays and one control voltage relay, there are provided two accelerating relays, 1AR and 2AR, two decelerating relays, DH and DL, and one overspeed relay OSR.

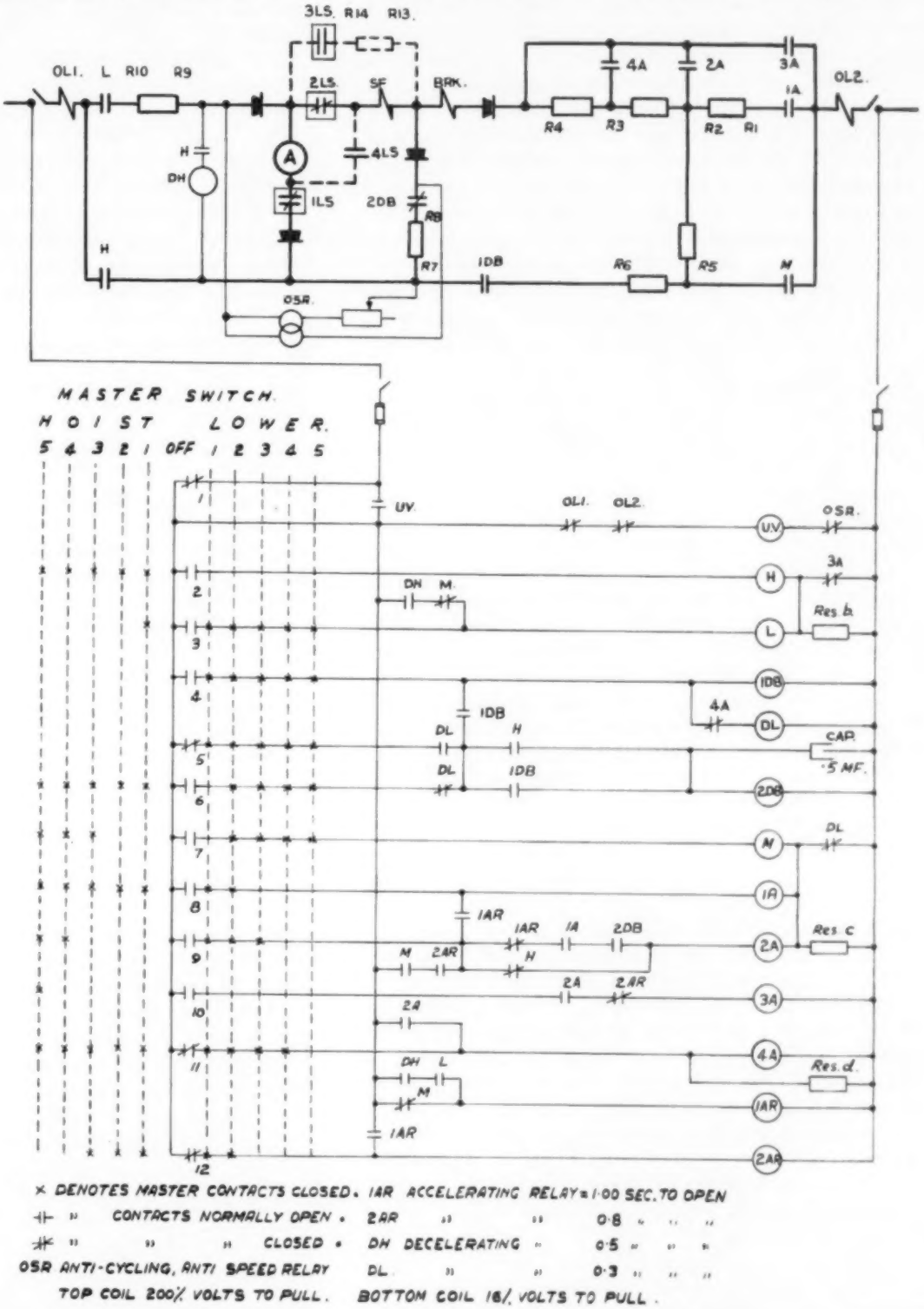

3LS. R14 R13.
OL1. L R10 R9
2LS SF BRK.
4A 2A 3A
1A OL2.
R4 R3 R2 R1
H DH
4LS
1LS 2DB R8
R7 1DB R6 R5 M
OSR.
MASTER SWITCH.
HOIST LOWER.
5 4 3 2 1 OFF 1 2 3 4 5
UV. OL1. OL2. OSR.
DH M. 3A Res b.
IDB 4A CAP. ·5 MF.
DL H
DL IDB
1AR IAR IA 2DB Res c
M 2AR H
2A 2AR
DH L Res d.
× DENOTES MASTER CONTACTS CLOSED. 1AR ACCELERATING RELAY = 1·00 SEC. TO OPEN
CONTACTS NORMALLY OPEN. 2AR " " 0·8 " " "
" " " CLOSED. DH DECELERATING " 0·5 " " "
OSR ANTI-CYCLING, ANTI SPEED RELAY DL " " 0·3 " " "
TOP COIL 200% VOLTS TO PULL. BOTTOM COIL 18% VOLTS TO PULL.

Figure 9—Schematic diagram shows connections for new hoist circuit.

The functions of the different relays and contactors which provide smooth and safe operations under any possible erratic and unrestrained movements of the master switch handle, are described as follows:

1. *Master switch moved to point-five "hoist"* — If the crane operator suddenly moves the master switch handle to its maximum "hoist" speed position with full load on the crane hook, the accelerating sequence goes rapidly to the point three circuit connections "hoisting", as shown in Figure 2, and the load begins to accelerate along the speed-torque curve 3 of Figure 3. The maximum hoisting accelerating torque developed at stand-still is 160 per cent which rapidly accelerates the load to about 22 per cent full-load speed. After a time-delay of about 1.0 second, the accelerating relay 1AR times-out and accelerates the load further to the speed-torque curve 4. The accelerating peak torque at that point is about 210 per cent which speeds up the load to about

64 per cent full load speed. After about 0.8 second of the timing-out of the relay 1AR, the second accelerating relay 2AR times out and the motion is transferred to the speed-torque curve 5. The accelerating peak torque at the point is about 220 per cent which speeds up the load to its maximum full load speed depending on the mechanical efficiency of the crane hoist mechanism. The control thus permits the crane rated full load to be hoisted to the rated full speed in steady steps without causing any abnormal jerks due to excessive peak torques. If loads higher than the rated full load are to be hoisted at higher speeds, the peak torques will necessarily be increased depending on the magnitude of the overload handled. It should be noted that due to the mechanical efficiency of the crane mechanism, the motor has to develop torques higher than its rated torque. This point should be taken into consideration while selecting the proper frame size of the hoist motor.

2. *Master switch moved from point-five "hoist" to "off"* — With light-hook, the maximum hoisting speeds as shown in Figure 3, can reach 250 per cent of the full-load "hoist" speed, even when the motor is so selected that the rated load is lifted at the rated speed and rated motor horsepower. In actual practice, all crane hoists are somewhat overmotored, and no-load speeds in excess of 275 per cent are often attained.

It would therefore be desirable to design a crane hoist control to provide automatic dynamic braking to slow down a fast moving hook block when the master switch handle is returned quickly to point-one "hoist."

In Figure 9, the relay DH initiates the rapid decelerating action to slow down the motion to the point-one "hoist" of the master switch. The relay DH controls the contactor L and the relay 1AR. The relay DH is a magnetic time-delay relay, which is set to pull in at about 80 per cent of the line-voltage, and drop out with a time delay of about 0.5 second when deenergized. With a crane efficiency of 85 per cent, the relay DH will pull in from point-three "hoist", when a light hook-block reaches about 170 per cent speed.

If the master switch is brought down to point-two "hoist" in order to slow down the hoisting motion, the contactor L gets energized over the auxiliary contacts of DH and M, both of which remain closed simultaneously at the moment. As the contacts L close, the motor power-circuit is brought to point-one "hoist", Figure 2, which brings the motion to curve 1 "hoist", Figure 3, which provides a heavy dynamic-braking action slowing down the hook-block to about 40 per cent speed.

The circuit thus provides a means to rapidly slow down a fast moving hook block near the over hoist limit switch, so that the chances of the hook block suddenly running into the limit-switch are reduced, if the crane operator is trained to pause at point-one while returning the master switch handle from "hoist" direction to "off" position.

3. *Master switch moved to point-five "lower"* — When the master switch is moved quickly to the point-five "lower", the accelerating sequence is held up at the point-two "lower" until the accelerating relay 1AR times out. The relay is set for 1.00 second. This delay provides sufficient time for the electro-mechanical brake to release. After the relay 1AR has timed out, the relay 2AR times out in about 0.8 second, which permits the main circuit to be held to point-three "lower" for about 0.8 second. The sequential delayed operation permits a smooth acceleration of the hook-block irrespective of the load. With no load, high starting kick-off torque on point-two "lower" gives rapid acceleration from standstill, so that the steel-wire rope is paid off quickly. With heavy load on the hook, however, the restraining dynamic braking action sets in quickly, and provides controlled acceleration until stable conditions are obtained.

The resistance R9-R10 which remains as a constant resistance in the motor power circuit limits the maximum current drawn from the powerlines to 200 per cent of the motor full-load current. The speed-torque curves in Figure 3 show that the crane-hook is accelerated in distinct steps, irrespective of the load.

4. *Master switch moved from point-five "lower" to "off"* — Every d-c crane hoist is subjected to high transient voltages, currents and torques, when a heavy load is to be brought to a standstill from its maximum lowering speed. In order to reduce the magnitude of those peak values, graduated dynamic braking steps are provided which delay the dropping of the electro-mechanical brakes to permit the motion to slow down sufficiently.

Such graduated dynamic braking is obtained by automatically holding the contactor coils 1DB and 2DB in energized position for 0.2 to 0.3 second, in order to prolong the dynamic braking action to slow down the motion. This is done by the provision of a time-delay relay, which is energized on the high speed lowering points and which is timed to hold back the contactors 1DB and 2DB for a fixed period, even though the master switch is quickly returned to "off" position.

There is a good deal of difference of opinion amongst engineers as to whether it is advisable to permit the delay in setting of the brake when an emergency is to be handled, because the addition of an extra relay may any time create a problem, if the relay fails to function in sequence.

It is essential therefore, that if the graduated dynamic-braking is to be provided, the sequencing relay should be so connected and the control so designed that a crane operator is able to deenergize the whole control by reversing the master switch and force the mechanical brake to reset instantly, in case the motion fails to stop due to the failure of the sequencing decelerating relay.

Referring to the control-circuit in Figure 9, relay DL is provided as a sequencing decelerating relay. This relay is energized only in the lowering direction on the last speed-point, when the contactor 4A opens out and closes its auxiliary contacts 4A, controlling the coil of DL. Relay DL is a magnetic time-delay relay with three contacts which control the contactors M, 1A, 2A, 1DB and 2DB. The contacts controlling 1DB and 2DB close, while the contacts controlling M, 1A and 2A open when the relay DL is energized. The contactor coils 1DB and 2DB get the retaining circuit over the contacts DL and over the master switch segment five which remain closed from "off" position to point-five "lower". Thus when the master switch is suddenly brought to "off" position from point-five, contactors 1DB and 2DB remain energized, permitting 1DB contacts to remain closed and 2DB spring-closed contacts to remain open, until the relay DL times-out. The relay DL is set to drop-out in 0.3 second. The contactors 1A and 2A are not allowed to close because the contacts DL remain

open in the coil circuit of 1A and 2A. As long as DL remains energized, the load is retained on the point-four speed-torque curve. Thus when the master switch is suddenly brought to "off" position, the speed is first stabilized at the point-four curve, and after 0.3 second time interval, when the relay DL times-out, the motor gets disconnected from the power lines and permits the brake to reset to hold the load to a stop.

It should be appreciated that a magnetic time-delay relay can fail to drop out due to the residual core-magnetism holding-up the relay armature in sealed position in actual service. Under that condition, the contactors 1DB and 2DB remain energized, which permits an overhauling load to keep on lowering at a steady speed. Such a condition would be dangerous, as the crane driver would lose his control over the crane motion.

Under such a condition, the driver would attempt to reverse the motion by reversing the master switch handle to "hoist" direction in order to plug the motion. The control circuit in Figure 9 indicates that, in spite of relay DL sticking, moving the master switch to "hoist" position, immediately opens the holding circuit of 1DB and 2DB contactor coils, which permits those contactors to drop-out. The interlocking of DL with M, 1A and 2A prevents those contacts to close in the "hoist" direction. as long as the relay DL remains sealed in. The motor thus remains deenergized and the brake sets in instantly to hold the load to a stop.

The circuit thus gives the fullest protection to the crane under all conditions. It prevents heavy plugging current surges, even if a careless crane operator were to move the master switch from point-five "lower" to point-five "hoist".

5. *Master switch moved from point-five "hoist" to point-five "lower"* — The "hoist" curves in Figure 4 indicate that a light hook block can attain a speed as high as 275 per cent of full-load speed. With a crane-hoist designed for a speed of 25 fpm the hook block will be moving at about 11 fps. If a crane operator inadvertently approaches the limit-switch at that speed and suddenly reverses the master switch handle to the "lower" position in an attempt to stop the motion, the control must so function that the field-weakening sequence is held back to the point where the motor can develop maximum plugging torque.

Relay DH gives the function of the decelerating relay under such a condition. The relay closes its contacts DH on the point-three "hoist". This relay is set to open its contacts after a time delay of 0.5 second when its coil DL is deenergized. If the master switch is suddenly turned from the "hoist" direction to "lower" direction, referring to the control-circuit in Figure 9, it is observed that the contactor L closes as soon as the master switch handle passes over the point-two "hoist". This gives a heavy motor dynamic braking action to slow down the motion. Simultaneously with the closing of the contacts L, the relay 1AR and 2AR also get energized. In the "lower" direction, the contactor L remains closed. The relay 1AR thus remains energized as long as the relay DH does not time-out.

After the master switch handle is suddenly turned from "hoist" to "lower", the field weakening sequence of the motor in the "lower" direction is delayed for 0.5 second. As the time delay of relay 1AR is set at 1 second, the motor is retained on the point-two "lower" for about 1.5 seconds.

The speed torque curve-two "lower" in Figure 4 provides a stalling-torque of about 80 per cent. Thus the fast hoisting hook block is brought to rest at a very fast rate, within half a second before the hook block can overrun into the hoist drum.

If the relay DH fails to drop out in case its armature sticks on account of the relay core residual magnetism, it will have no adverse effects because in that case, the control will be retained on point-two "lower".

The circuit thus provides double protection against overhoisting of a light hook, by first producing a heavy dynamic brake to the motion as soon as the master switch returns to point-two "hoist" to slow down the motion, while the heavy plugging circuit is retained for a longer period, in case the master switch is suddenly reversed to the "lower" direction.

6. *Failure of dynamic-braking-action during lowering* — When an overhauling load is lowered, the motor itself supplies the restraining torque, termed the dynamic-braking-torque of the motor. The load tends to drive the motor which becomes a generator, the motor being connected as a shunt-machine during lowering, with the electro-mechanical brake coil connected to the motor field circuit. If therefore for some reasons, the motor-armature loop-circuit becomes open-circuited at some point, the motor regenerative-action fails and the load begins to race downwards due to unrestrained gravity action, while the brake remains energized over the motor field circuit. Such an overspeeding can cause a serious accident where the motor armature and the hoist mechanism can be broken due to overspeed, in case the crane operator fails to return the master switch to "off" position and allow the brake to reset. Motor armatures are often returned to shops in smashed-up conditions, which are the result of such over-speeding which could not be arrested in time.

The open circuit in the motor armature loop can occur at several points. The most likely is at the motor armature trolley cross bar collector. To reduce this possibility, the present day practice is to provide two parallel collector shoes in the motor armature circuit.

With control schemes, where an armature-circuit series resistance in the "lower" direction is provided, it is possible that the resistance may break or burn out, causing an open circuit of the armature loop. In extreme cases, the armature circuit dynamic braking contacts 1DB can fail to close properly, if the contacts are badly worn-out and not changed in time.

Another cause of the failure of the dynamic braking action due to an attempt to lower with the overhoist limit switch in tripped position is already explained.

In Figure 9, relay OSR is provided to give automatic protection against overspeeding due to the failures of the motor dynamic braking action.

The relay OSR is a two-coil relay, one coil of which is connected across the motor series field, and the other coil is connected across the motor armature.

If the motor armature loop is open circuited due to the breakage in the resistance R6-R7, as shown in Figure 9, the dynamic braking action would fail and the load would begin to accelerate faster. As the motor field remains energized, the voltage across the motor commu-

tator brushes increases. This voltage is impressed on the relay coil which would operate the relay OSR. The relay OSR controls the undervoltage relay UV, which in turn controls the whole control circuit. As the relay OSR pulls-in, its contacts OSR open and deenergize the coil of the relay UV, which removes the control power from the circuit and disconnects the motor from the power lines, forcing the electro-mechanical brake to reset which holds the load to a stop.

The coil of the relay OSR which is connected across the motor armature, has a control resistance which is adjusted such that the relay does not operate on the highest transient voltages that are likely to occur during normal operations.

The second-coil of the relay OSR which is connected across the motor series field, protects the crane against the over speeding of the "hoist" due to lowering a load with the tripped limit switch. In Figure 6 is shown the connections of the relay OSR as it would function during the lowering with the over hoist limit switch in tripped position. The motor power circuit connections over the limit switch contacts have already been discussed. From Figure 6, it is observed that the bottom coil of the relay OSR gets connected in parallel across the motor terminals. The voltage impressed on the relay coil is therefore the voltage across the motor. As the motor is shunted by the resistance R13-R14, the maximum voltage across the motor is limited by the voltage drop across the resistance R13-R14. As soon as the master switch is moved to "lower" direction with limit switch tripped, the contacts L close, and the motor gets connected across the power lines. The starting current is limited by the resistances R1-R2 and R9-R10 only, as the resistance R13-R14 is shunted by the very small internal resistances of the motor armature and the motor series field. The starting current is such that it gives sufficient torque for the motor to rotate in the "lower" direction. As the motor develops its back emf, the current begins to bypass over the resistance R13-R14 until stable conditions are reached. The coil of the relay is so dimensioned that it can pull in the relay at 36 volts or 16 per cent of the normal voltage, for a 230-volt system. Under actual service conditions, the crane hook block will begin to lower before the relay operates. The relay OSR might function and set the brake before the hook would move to the proper distance for the resetting of the limit switch to normal position. Depending upon the load on the hook, it may become necessary to make one or two additional attempts before the hook block can lower to the proper distance for the limit switch to reset.

As already explained, an overhauling load while being lowered with tripped limit switch, tends to run away. The relay OSR thus gives an automatic protection to prevent an extreme racing condition, if the overhoist switch accidently fails to return to normal position due to jammed bearings or any other possible mechanical defects.

The relay OSR is set at such a value that it will operate instantly at any point of the master switch in case the limit switch accidently trips over during the lowering. The relay however does not operate on any transient overvoltages under normal operations.

Referring to Figure 5, it is observed that, if a load is overhoisted to limit switch operation with the master switch retained in point-one, the circuit formed over the limit switch contacts gives a "lower" direction connection. This would reverse the direction of rotation of the motor and the load would then move downwards until the limit switch resets. This would thus give cycling up-and-down operations of the hook block in the limit switch zone, if the master switch is retained in point-one "hoist". The relay OSR automatically prevents such cyclic movements, because as soon as the load begins to lower, the relay OSR will operate and deenergize the whole panel. The relay OSR thus serves also as an anti-cycling relay.

7. *Failures of contactors or relays in service* — Most well-designed electrical controls do give good service, as long as they are in good normal conditions. However, when sudden faults develop at crucial weak spots, the control does create dangerous unstable conditions. The dangerous situations created by the failure of overhoist limit switch during lowering, or the failure of the motor dynamic braking action have already been discussed.

Sudden failures of a contactor or a relay during operation, in many cases, do create heavy short circuit current peaks or a runaway condition, resulting in bad mechanical damage.

Thorough analysis of the control scheme in Figure 9 will show that the scheme is designed for maximum self-protection. Any failure of a contactor or a relay makes itself self-evident from the peculiar behaviour of the operation.

The contactors which can create extreme conditions are H, L, 3A, 1DB and 2DB. The contactors H, L and 3A are mutually so interlocked that direct short-circuit on the power-lines due to accidental simultaneous closing of the contacts out-of-sequence is prevented. If 1DB fails to close, or if it opens-out during lowering, the contacts 2DB instantly close and provide a stable slow speed to the crane hoist, because a self-regenerating circuit is provided by the spring-closed contactor 2DB. On the contrary, if the contacts 2DB fail to open or if the contacts suddenly close due to burning out of the coil 2DB during hoisting, contacts 2A would immediately open out and introduce a resistance into the motor circuit to prevent a heavy current through the resistance R7-R8, which current would otherwise flow and overheat the resistance. Failure of any other contactors to function during lowering does not have any abnormal effect on the operation.

The magnetic time-delay relays 1AR, 2AR, DL and DH on a crane controller would often fail, mostly due to sticking of the relay armature due to core residual magnetism if they are not serviced properly. Sometimes, the relay coils burn out and make the relay ineffective.

With the circuit of Figure 9, none of the relays create any dangerous unstable conditions, either during hoisting or lowering. On the contrary, the condition of the faulty relay makes itself self-evident by the different but stable behaviour of the crane hoist, which would be typical to the malfunction of each relay.

The control scheme employs only nine power circuit contactors, two accelerating relays, two decelerating relays and one dynamic braking action failure relay, besides one normal undervoltage and two over-current relays. The total number of relay contacts is 14. The

relays DL and 1AR have three contacts each, and the other relays have one or two contacts each. The number of auxiliary contacts for sequential and safety interlocking provided on the main contactors is 15.

SUMMARY

The steel industry today has accepted seven major crane-hoist control schemes which have been in normal service. Each of these schemes has special features, but each has its weak spots especially under the faulty operating conditions described and discussed above. Failure of a contactor or a relay may create dangerous current peaks or runaway conditions, which may result in motor armature flashovers or mechanical damage to the equipment. Such experiences are common to steel plants, and several such incidents have from time to time been reported and discussed in the "Iron & Steel Engineer".

This paper presents a new "hoist control scheme" which is designed to give a simple and more straightforward main motor power circuit having the most desirable speed-torque characteristics, which at the same time gives a comparatively simple control circuit. Specific relays are provided for each critical function. The relays are so connected that their failure to function properly in sequence, has no serious or dangerous effects on the crane operation.

Comparison with other control schemes in use on steel plant cranes will show that few other schemes provide such good speed-torque characteristics, simplicity and safety of operations under the normal and the various abnormal conditions.

MODERN RAPID METHODS OF CHEMICAL ANALYSIS FOR QUALITY CONTROL*

▲ THE insatiable demand for steel products in recent years has stimulated research and technical progress to produce steel at an ever-increasing rate. In the modern steel plant of today it is essential that the steel production rate be as fast as possible, consistent with satisfactory costs and maintenance of quality standards.

In former years there was a feeling among some steel producers that quality steels could not be produced at a high rate. Such thinking is not necessarily true, as the best quality will be produced when the optimum degree of slag constitution, temperature, and chemical composition of the metal has been achieved. If satisfactory and rapid methods are available for determining these factors, it is reasonable to expect that the quality will be right for the intended end use of the product and that the production rate will be at a maximum. This discusses only the last-mentioned factor, namely, chemical composition of the metal, and in particular the equipment and methods used in the various plants of Bethlehem Pacific Coast Steel Corporation.

Both open hearth and electric arc types of furnaces are used, which vary in size from 60 to 75 tons in the open hearth to 65 to 90 tons in the electric furnaces. All furnaces use a charge of scrap and some of the plants use varying amounts of cold pig iron. The production rates vary from approximately 10 tons per hour in the open hearth furnaces to 21 tons per hour in the electric arc furnaces.

To produce a steel of satisfactory quality it is of primary importance to know the composition of the molten metal during the refining period, and for quality control purposes the greater the speed with which an analysis can be made, the greater the possibility of a more accurate control. The reason for rapid analysis is, of course, apparent because of the continuous change of composition due to the oxidation of the molten bath by the slag. It should, of course, be understood that accuracy of analysis is paramount and that speed of analysis, while important, is secondary to accuracy.

Probably our most valuable analytical tool for quality control is the spectrograph, because the results obtained with it will quickly indicate if the composition of the metal is fundamentally correct, as far as residual elements are concerned.

For the determination of carbon in preliminary tests we employ either magnetic or combustion methods; for final tests we use only the combustion method. These procedures have been in use for a long period of time and the most significant improvement has been in weighing balances and new types of furnaces.

It has been our experience that the combustion method for sulphur has many advantages that recommend its use for our operations. This method is very accurate, especially for alloy steels, and particularly for those containing molybdenum. It is also quite rapid, as the required time for the determination is approximately six minutes, and if an automatic electronic titrator is used the operator is free to do other work.

In conclusion, considerable progress has been achieved in recent years in reducing the time required for chemical analysis, which in turn has been effective in making quality control more certain and easier of attainment.

*Abstracted from paper by Hubert C. Swett, Chief Metallurgical Engineer, Bethlehem Pacific Coast Steel Corp., San Francisco, Calif., presented at San Francisco Regional Technical Meeting of American Iron and Steel Institute, October 21, 1955.

Control Systems Using Non-Contacting Thickness Gages

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▲ IN any production control system, there are several functions which are always performed, regardless of the product. For convenience these can be described as: (1) measuring, (2) controlling, (3) monitoring, (4) recording, and (5) classifying.

It is elementary that the output of any process must be measured in some way. Perhaps this is nothing more than periodically glancing at the product; or it may involve very extensive and precise analysis; but in any case some measurement is made. Second, if the measurement indicates that the product is not exactly what is desired, some corrective or control action is taken. Third, the proper performance of the first two functions must be monitored to insure that the measuring equipment or techniques have not gone awry or that the controller is not initiating faulty action. Fourth, production records must be kept which are of use not only to the production department, but also to the accounting department, the sales department and others. Fifth, and finally, the output must be classified and the out-of-tolerance product rejected; for if this is not done by the producer, it will certainly be done by the customer.

All five of these functions are of equal importance, and everyone can think of examples wherein improper performance of any of them has caused serious trouble. This paper describes some uses of non-contacting gages and accessory equipment for continuously and automatically performing several or all of these functions in the production of cold-rolled strip, hot-rolled strip, continuous galvanized strip, and electrolytic tinplate.

The performance of the last four of the outlined functions depends completely on the accuracy, reliability, and speed of performance of the first. Hence, development of any continuous and automatic control system must await development of a continuous and automatic gage to measure the variable which is to be controlled. Non-contact gages for measurement of thickness have been developed to a high level of accuracy, reliability and speed.

Practically all non-contact thickness gages utilize some sort of radiation, commonly either X-rays or beta rays, to make the measurement. In measuring total strip thickness, a source of radiation is mounted underneath the strip, a detector above. The radiation which penetrates the strip is inversely proportional to the weight of the strip. Since the density of any metal is very nearly constant, the gage can be calibrated in thickness.

In the design of equipment for automatically performing the functions of production control, there are certain requirements which must be satisfied. The measuring gage must have three basic characteristics: (1) accuracy, (2) dependability, and (3) high speed of response. It must maintain its accuracy under all conditions of operation. For the entire system to be truly automatic, the measuring gage must be truly automatic and permanently calibrated. Yet it is self-evident that any radiation gage "sees" everything which appears between its source of radiation and its detector; this includes not only the strip being measured by also any rolling oil, dirt, grit, or other extraneous material which may accumulate on the gage head. Hence, it is incumbent on the designer to furnish some method of automatically recalibrating or "standardizing out" such extraneous effects to insure dependable accuracy, not subject to human error or forgetfulness.

. . . . automatic control systems cut down variations in product size and quality, and as a result give more economical mill operation . . . . problems must be solved, however, in designing control systems to utilize the high speeds available in the modern mills . . . . these problems are being successfully overcome in the newer equipments now becoming available . . . .

Equipment designed to perform the second function, controlling, must be designed not only to cause the proper control action to be taken when necessary, but also to be completely "fail safe." This leads into the third function, monitoring.

It is axiomatic that anything which has ever been built can fail. The designer of a truly automatic control system must provide monitors which will do two things:

(1) make any failure immediately apparent to all concerned, and (2) shut off all control action in a safe way; i.e., so that no damage can be done to the process machinery. Ideally, the measuring gage should be like an adding machine in that it will either give the right answer, or it will give no answer at all. If the measuring system should fail in a way which would otherwise give an erroneous measurement, a monitor should shut off the gage, shut down the control or perhaps the entire process, and sound an alarm. It can sometimes occur that in the final design of a control system the monitoring and safety circuitry is more involved than all the rest of the equipment.

The fourth function, recording, must be considered in terms of which departments of the company are to use the records. Records of interest to production personnel and also perhaps the research and maintenance departments, should include the maximum possible detail; therefore, a wide-strip recorder is ideal. However, such a record is entirely too detailed and not in the proper form to be of use to management, accounting, or other departments. Therefore, a completely mechanized control system should include data reduction equipment which, for example, may totalize the number of feet of strip within tolerance versus that out of tolerance. Such equipment should read out either on counter dials or directly on punched cards for further processing through accounting machinery.

The fifth function, classifying, is made necessary by the fact that any control system is finally limited by the inherent characteristics of the process machinery. For example, it will probably always be necessary to shear off and reject some material from the head and tail ends of rolled coils, regardless of how fine a mill control system may be developed.

Since practically all flat products are produced in the form of coils and later sheared, punched, or otherwise cut into smaller pieces by either the producer or the fabricator, it would seem most economical for the classifying function to be performed in conjunction with the shear or punch. For a producer of sheets, this presents little problem. Classifying or sorting conveyors with electrically-controlled gates to drop sheets into different bins have long been available and are in use, activated by thickness gages, pinhole detectors, and other measuring devices. Coil stock, on the other hand, presents a different problem. Although some large consumers have installed automatic classifying equipment and others have very involved incoming inspection procedures, it may be desirable for sales reasons for the producer to assume this function. This means classifying to a much finer degree than merely guaranteeing that the product is within commercial tolerances, for variations well within this magnitude can cause trouble in many fabricating operations. Perhaps many of the problems facing users of coil stock could be solved if the strip were marked in such a way as to show the exact characteristics of the strip at each point. Many types of marking devices are available which could be actuated by thickness gages or other measuring devices.

A final type of classifying situation is that of handling sheets after they are sheared. This is commonly encountered in re-classifying sheets which have been rejected by a previous classifier, so that those which can be sold in a different tolerance range can be salvaged from those which must be scrapped. Because of the gaps between successive sheets, the designer of automatic gaging and classifying equipment must provide very high speed of response indeed, so that the line may move at a reasonable speed and yet allow each sheet to be accepted or rejected.

It is believed that this discussion has outlined the direction in which the gage and control manufacturers are heading. It would be ideal if it could be said that systems are commercially available for complete production control of those processes covered by this paper, i.e., hot strip mills, cold reduction mills, continuous galvanized lines and electrolytic tinning lines. Unfortunately this is not true; however, in recent years and particularly in recent months, some rather significant steps have been made, notably in control of cold-reduction mills.

It has long been recognized that some, if not most, of the variations in gage of the output of a cold-reduction mill have their origin in the hot-rolling process. For example, in many cases it has been shown that every coil coming from a cold mill has four clearly identifiable heavy spots along its length directly resulting from the water-cooled skids in the slab heating furnace ahead of the hot strip mill. Another common characteristic is the gradual increase in gage from head to tail end due to cooling of the slab in the hot mill, particularly on the runout table ahead of the finishing train. It is the proper function of the cold reduction mill to iron out these variations within the coil and also to put the average thickness of each coil on specification.

The first step in the control of a tandem mill was considered to be the elimination of the variations in the incoming strip. It was felt if the strip entering the second stand were uniform in gage, then it and all succeeding stands would require little adjustment within any one coil to maintain a constant finished gage. The best way to accomplish this is to apply automatic screw control to the first stand, since at this point the steel is still relatively soft and also moving slowly so that the mill screws have enough time to act. The first known successful installation of this type of controller on a tandem steel mill was made at the Republic Steel Corp.'s Niles, Ohio, plant in November, 1953, and the expected results were obtained. Since that time many such installations have proven the effectiveness of this type control in increasing yield percentage and causing a more uniform product.

Figure 1 shows an excerpt from a chart recording the thickness of the strip after the first stand of a tandem mill rolling tinplate gages. At the time this recording was made, the screws were not being automatically controlled. The magnitude of the variations shown is typical. The light to heavy drift through each coil is quite apparent. Especially striking is the sudden change of thickness at the point where the head end of one coil is welded to the tail of the preceding one to make a double coil. This change is typically of the order of five to ten per cent.

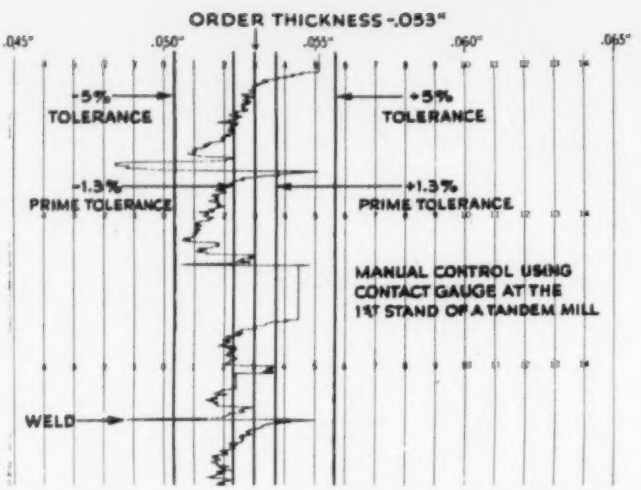

Figure 1 — Chart shows strip thickness on the first stand of a tandem mill using a contact gage and manual control.

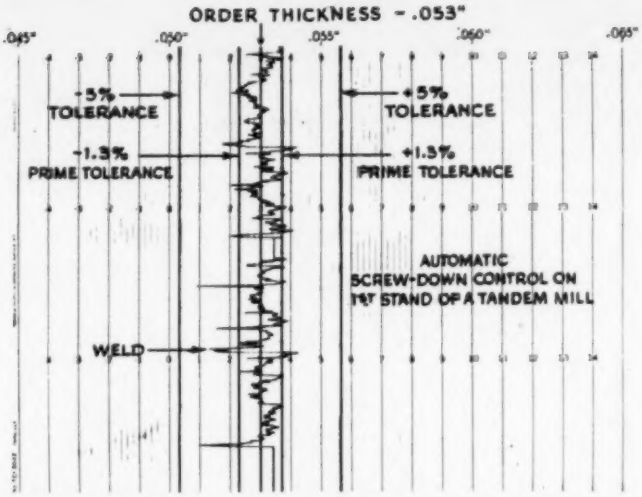

Figure 2—Chart shows operation on same order and same mill as that of Figure 1 except that automatic screw-down control is used. Note smaller variations in gage.

Figure 2 shows the same mill running the same order, but with automatic screw control. It can be seen that the strip is being held almost entirely within the prime tolerance band. When a sudden change occurs, the screw setting is changed as rapidly as the screwdown motors can be made to move.

Figures 3 and 4 show the totals of two five and one-half hour runs on the same order, the first without, and the second with automatic screw control. It can be seen that with normal manual control, only 28 per cent of the product was within 1 per cent of the desired thickness; whereas, with automatic control, 92 per cent was within the range.

It should be emphasized that these graphs represent the thickness at the exit of number one stand and not the finished gage thickness. It was recognized from the beginning that control of the first stand of the tandem mill was only the first step. In actual practice, the producers who are using automatic screw control of the first stand are also using non-contact measuring at the finishing stand to allow manual control of the rest of the mill. The next step, then, is quite obviously automatic circuity actuated by the finished gage. There are several methods by which control might be undertaken. First, the control signal might be cascaded to reset the control point of the first stand controller so that all automatic control action would be taken by the first stand screws. Second, control signals from the finishing stand might be used to change the speed of the first stand. Third, the finishing stand speed might be controlled directly. There are many other possible systems.

In designing automatic controls for any process, the designer will normally attempt to duplicate by automatic means the actions formerly taken manually. Unfortunately, in the case of tandem cold mills, standard rolling practice is no guide because it varies too widely from mill to mill. In some cases, all routine adjustments of finished gage are made by varying the speed of the first stand. In others, coarse adjustments are made with the screws on the first stand and fine adjustments with finishing stand speed. In at least one case, a roller was observed making all routine adjustments with the screws of the second stand. When asked why, he answered that it seemed to work well. His record confirmed that fact.

Of all the possible systems, control of finishing stand speed seems the most attractive for general use because it is faster acting and finer control should result. However, a much greater responsibility is thrown onto the monitoring and safety circuits, since the strip at this point is full hard and traveling at high speed, hence is easily broken. Such an installation was made early in 1955. It is the writer's belief that this is the first successful installation yet made including both first and last stand control of a tandem steel mill; however, several gage and control companies have been working along these lines and some other installation may have antedated this one. Early results look highly promising; however, it is too early to draw firm conclusions.

A reversing cold mill can be treated like the first stand of a tandem mill and automatic screwdown is capable of giving excellent control at every pass down to and including finished gage. Two measuring gages are required, one on each side of the mill, and the control circuits are automatically switched back and forth as the mill reverses. One slight difference in gage design results from the fact that most reversing mills run a wider range of alloys than most tandem mills. Since the calibration of any radiation gage is affected to some degree by the composition of the measured material, a calibration switch must be included. Ideally this should have several discrete positions clearly labeled "Carbon Steels," "300 Series Stainless," "400 Series Stainless," etc., so that the calibration is automatically adjusted to fit the alloy when the switch is positioned.

Automatic control of hot strip mills has not yet, to the writer's knowledge, been accomplished. However, a great deal of engineering manhours are being expended in the study of the problem by the steel companies and the equipment manufacturers. Almost all hot strip mills are equipped with non-contact gages; and it is a dogma of automation that anything that can be measured can be controlled. Given the speed with which developments are being completed, the writer feels it to be certain that a hot strip mill will be equip-

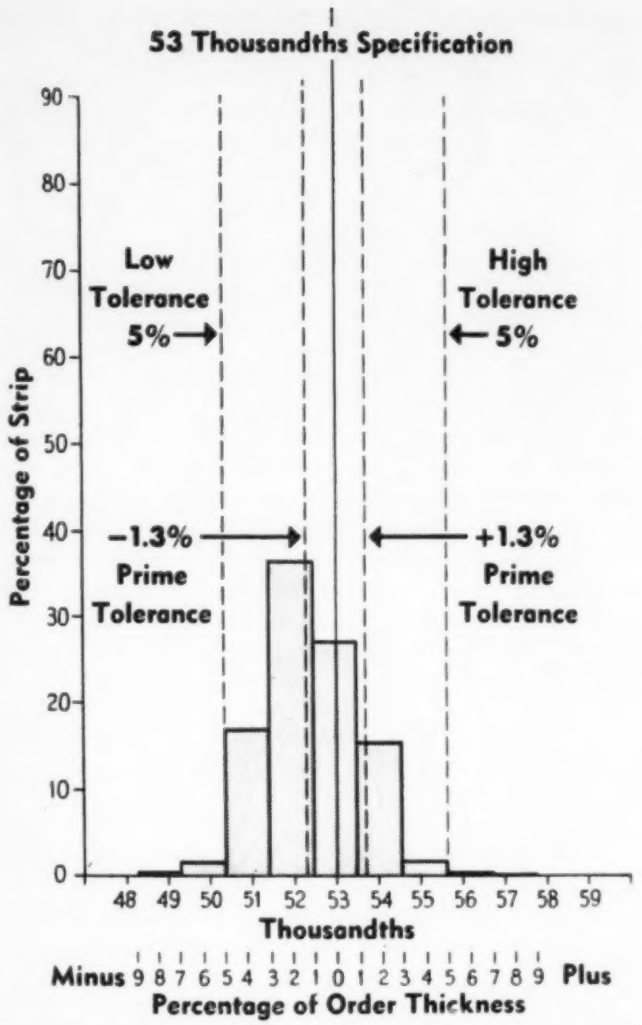

Figure 3 — Chart shows percentage of tin plate which meets tolerance requirements on the same mill and order as that of Figure 1 using manual screw control.

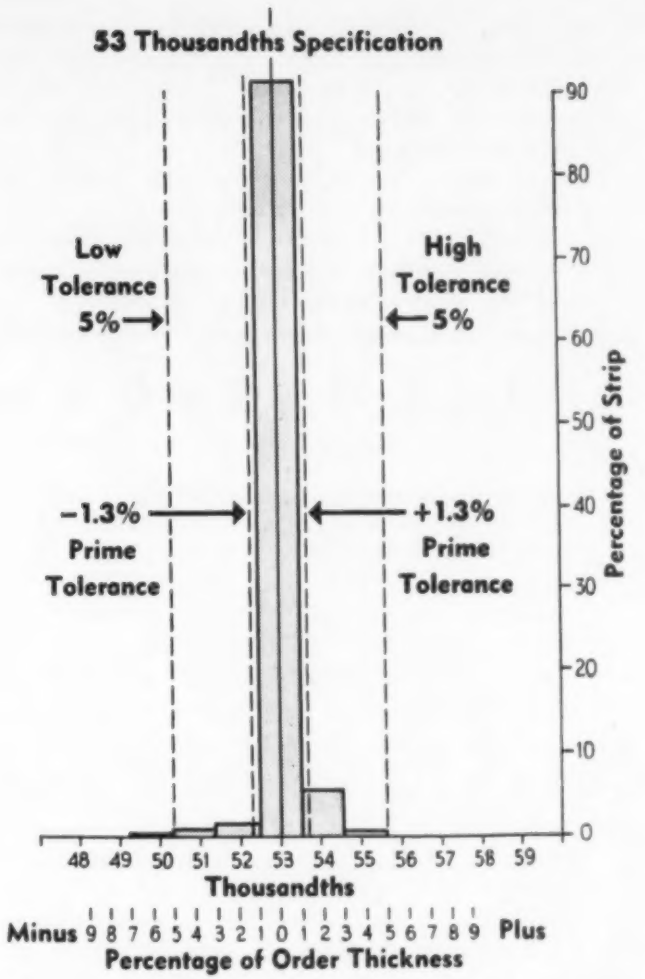

Figure 4 — A larger percentage of the product meets required tolerances with automatic screwdown control, and this is shown by this chart which is run on the same order as that of Figure 3.

ped with automatic thickness control within eighteen months.

Up to this point, all characteristics discussed in this paper applied equally to any radiation gage; that is, either of the X-ray or beta ray type. However, in discussing non-contact measurement of coating thickness, differentiation between the two types must be made. It is understood that an X-ray coating thickness gage operates on a fluorescence principle; that is, X-rays are beamed at the strip, penetrate through the coating, and excite the base metal which in turn re-radiates X-rays of entirely different wave length. It is this secondary radiation which is used to measure the coating thickness. The writer is not qualified to discuss this type gage further.

The beta ray thickness gage is apparently almost a true reflection gage in that beta rays are beamed at the strip, penetrate the coating, bounce from the base metal, back through the coating, and are detected. As the coating weight increases, the number of beta rays which return to the detector either increases or decreases, depending on the relative atomic weights of the base and coating materials.

Essentially the same beta reflection system can be used to measure coatings of zinc, tin, aluminum, enamel, or other materials on any homogeneous base material such as steel.

The design of a system for measurement and control of a continuous galvanizing line should include two measuring heads, one for the top side, the other for the bottom, with a summation computer to add the two coating weights. The gages should scan across the strip to indicate edge-to-edge as well as machine direction variations. Precautions must be taken in installing such a unit to insure a constant pass-line of the strip. because deviations of more than plus or minus 0.030 in. from the mean position can cause errors in the measurement. If this pass-line tolerance is held, however, this system will give a continuous measurement with a high degree of accuracy. In fact, according to tests made by personnel of various steel companies, the reflection gage seems to show greater accuracy and repeatability than the destructive chemical stripping tests used to check it. Now that a measuring system is available, automatic control of coating thickness has become inevitable and will be accomplished in the near future.

Measurement of electrolytic coatings on tinplate offers much the same problems as zinc coatings, with the added factor that the gage must have very high sensitivity indeed, because of the light weights of coating applied. Exhaustive laboratory tests and at least

one temporary installation on a continuous electrolytic line have indicated that measurement to accuracies of the order of 0.01 lb per base box is obtainable, and a permanent type unit is under construction for installation in the near future.

In conclusion, it would seem that from a glance at the field of automation of strip processes, one is struck not so much by what is presently being accomplished as by the rate at which developments are being made. The next five years promises fascinating progress.

DISCUSSION

PRESENTED BY

W. E. MILLER, Manager — Steel Mill Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

DR. DAN M. HAYES, Research Metallurgist, Research Laboratories, Armco Steel Corp., Middletown, Ohio.

W. E. Miller: Industry interest in non-contact gages and in utilizing these gages as part of automatic control systems is indeed keen. Non-contact X-ray gages are installed on a large number of tandem cold strip mills. Mills of this type installed since 1948 are also well instrumented, and have generally been provided with practically all the control functions regulated. I would agree that there is general industry agreement as to how the operator might manually control the gage and as to how the automatic gage control system might improve upon it. Rapid progress is being made in providing automatic gage control for these mills.

Hot strip finishing mills have not been as completely instrumented nor have control functions been as completely regulated. As a result there is not the same general agreement among operators as to how automatic control of gage should or might be accomplished on these mills. Several such mills are now being placed in operation with, or being modernized to have, very complete instrumentation and a complete complement of modern feed-back control systems. These particular mills and a large number of other hot strip finishing mills already have non-contact X-ray thickness gages. It is expected that information will become available that will make possible an automatic gage control system for hot strip finishing mills.

On a tandem cold strip mill the author has outlined several methods by which automatic control of gage could be extended to operate from a gage located following the last stand. Work we have done would indicate full agreement with the same preference towards speed control of the last stand.

Dan M. Hayes: The author is to be congratulated on a clear, concise presentation of a rather involved subject. It should be specifically pointed out that the gains reported in the case of cold mill controls are those associated with automatic control and are not necessarily associated with non-contacting thickness gages. The same gains have been made by using existing contact gages in conjunction with a suitable controller. There are advantages to be gained from the use of contact as well as non-contacting radiation type thickness measuring equipment. One advantage of a contact gage is that the measured parameter is independent of composition. In the case of steel, this may outweigh the advantages of not contacting the strip.

In the case of coated materials, the back scatter principle allows a continuous control to be substituted for a spot check. This generally results in both quality and cost gains. Experience with this equipment on continuous coating emphasizes the point that constant geometry must be maintained between the measuring head and the surface of the material in process, if suitable accuracy is to be attained. This is much easier to say than accomplish in the case of coated steel strip.

Limited experience in this field leads to the opinion that rapid gains in quality and decrease in cost will be made in the future through further application of automatic controls in the metal processing industries.

WANTED!

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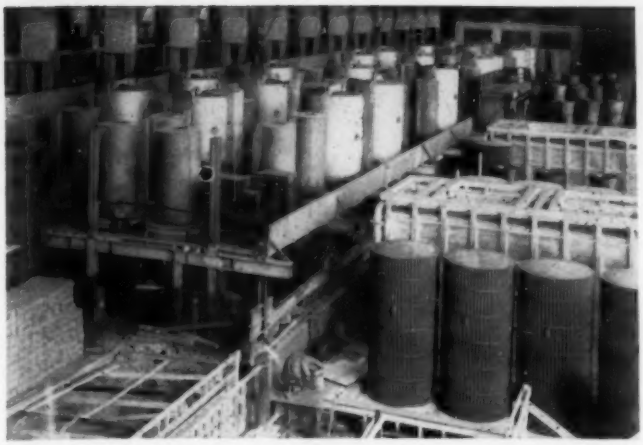


Figure 1 — View shows about one-half of the original annealing facilities, the bell-type electric annealers. Two of the new units can be seen at the right.

By JOHN H. SPRAGUE
Fuel and Utilities Engineer
Steel Division
Ford Motor Co.
Dearborn, Mich.

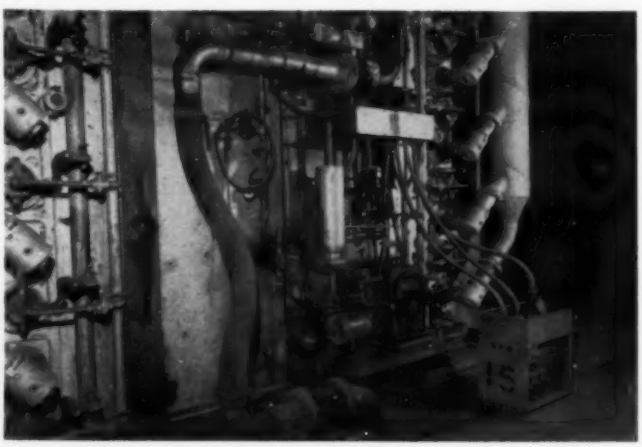
New Annealing Facilities for Ford Motor Co.'s Steel Division

▲ AS part of a modernization program, Ford Motor Company replaced facilities in 1951 for the annealing of cold rolled sheets. The existing cold reduced sheet annealing facilities at Ford's were so located and of such type that processing and handling costs were excessive for this operation. Rolling equipment was limited by design to the processing of maximum size coils of 54 in. weighing approximately 450 lb. per lineal inch of width. To reduce operating costs to a profitable competitive basis, it was necessary to consolidate annealing facilities and adopt modern methods of large coil processing.

The annealing processes were carried on in four separate locations. On the west side of the rolling mill, there were four gas-fired radiant tube covers and twelve eight-stack bases with a capacity of 12,650 tons per month. These covers, because of limitations imposed by building heights, could be used only on three consecutive bases. Five similar covers and twelve like bases were located on the east side of the rolling mill. Their capacity was 15,800 tons per month. There were no building height limitations here so any furnace could be used on any base.

. . . . fuel rate at this installation is abou 1,000,000 Btu per ton with heating rate of ten tons per hour on loads of over 180 tons . . . . tons per furnace hour, however, vary with product mix . . . .

Figure 2 — One of our new four-stack radiant tube covers shows the controls and fan which are all located on one end.



The oldest group of coil annealing facilities, 38 single stack electric bell furnaces and 114 bases with water seals for the inner covers, were located at the north end of the same building. The capacity of this equipment was about 15,000 tons per month. One hundred and ninety pyrometers, five for each furnace, and the necessary switch gear were required to control temperatures in these furnaces.

Coils were also annealed in another building located south of the rolling mill. These coils were packed separately in sealed containers and were charged into 38 direct-fired furnaces of the in and out type.

These facilities had been used to heat treat tank parts during World War II. Their annealing capacity

Figure 3 — To the left can be seen the cooling tower for one of the atmosphere generator units. The condenser for the unit is on the right with its refrigerant compressor just below it.

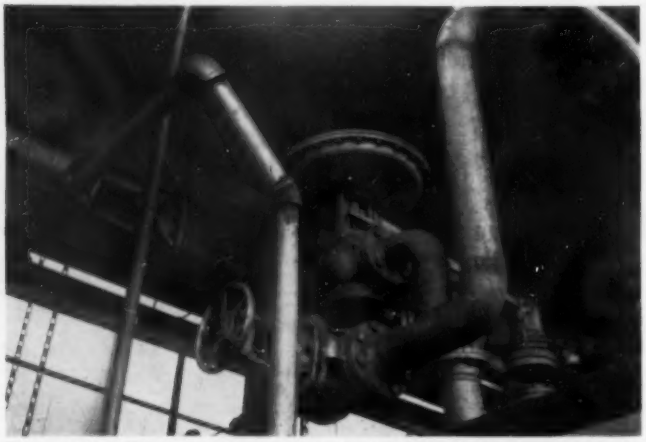


Figure 4 — This regulator (center) controls the pressure in the atmosphere gas main by bleeding excess to the roof.

Figure 5 — This shows a method of supplying atmosphere gas to an innercover through the recirculating fan motor. Also seen is the duct for circulating cooling air around the top bearing and between the inner and outer motor shell. The base thermocouple can be seen at the right-hand edge.

was about 5,000 tons per month. Only the facilities in the "Y" Section were adjacent to the cold reducing and finishing operations.

The cost to operate these other annealing facilities was extremely high due to the excessive handling and transportation of the steel. The electric bell furnaces were obsolete and their operating costs were high when compared to the gas-fired furnaces. The building which

Figure 6 — Some of the eight furnaces and twenty-one bases which comprise the south end of the annealing facilities. A portion of the storage area is on the left.

contained the in-and-out furnaces was to be razed to make room for the erection of a new stripper building.

A study of the cold reduced sheet facilities showed that the existing cold roll equipment should be altered to handle coils up to 840 lb. per in. of coil width with a maximum weight of 50,000 lb. for 60-in. wide material, and install modern annealing equipment in the existing "Y" Section of such capacity as to meet our production requirements.

An analysis showed that new modern annealing facilities could be installed at a cost lower than consolidating and expanding our existing equipment. A substantial cost saving could be effected by improving our existing cold reducing facilities, and providing additional equipment to process coils up to 66-in. outside diameter and 24-in. inside diameter with a maximum weight of 50,000 lb.

In brief, the steel division wanted to streamline its product flow and produce a larger coil, thereby reducing handling costs and coil damage. The nine radiant tube and the 38 electric covers together with their bases and the 38 direct-fired furnaces were all abandoned in favor of more modern annealing facilities.

The new equipment was designed to accommodate present capacity. Coil size increased from 54-in. outside diameter and 30-in. inside diameter to 66-in. outside diameter and 24-in. inside diameter, and pickle lines, mills, shears, etc., were revamped to handle these "Jumbo" coils. The new facilities were designed to fit into the product flow and had to leave room for possible future expansion.

Sixteen furnaces with 41 bases were installed. The covers, themselves, are end fired radiant tube furnaces, 12 tubes on each end, designed to operate on four-stack bases. The stacks are in line running from east to west and have a piling height of 161 in. Waste gases are expelled by a fan mounted on the cover near the top. Secondary air is induced by this fan at the 24 burner locations. The burners are designed for 495 btu mixed gas and sized to burn the available air when supplied with gas at 20 in. water column at the burner spuds. The gas pressure control serves not only to govern pressure, but also to shut off the flow of gas when

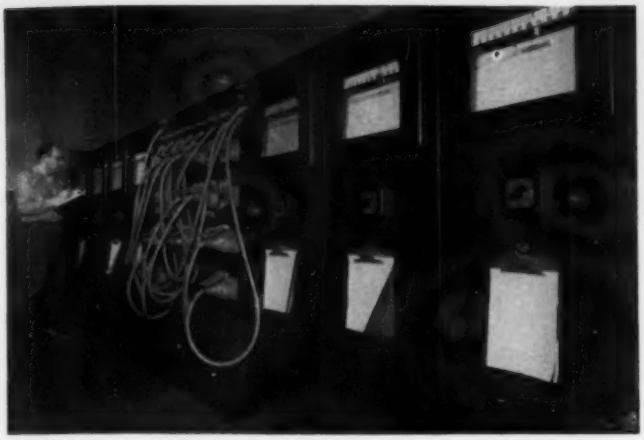


Figure 7 — Just below each pyrometer is a four-point selector switch enabling the operator to use any of the four base couples as the "work" control couple. The plugs and receptacles seen in the photo are used to connect the pyrometers to the desired bases.

Figure 8 — These cubicles, containing switchgear for two of the forty-one bases, are typical and are located in control rooms convenient to their respective bases.

Figure 9 — Emergency shut-off valve for the furnaces in the south section. In this position, the normal operating position, both ends of the cylinder are open to atmosphere so there is no hindrance to closing the valve by hand.

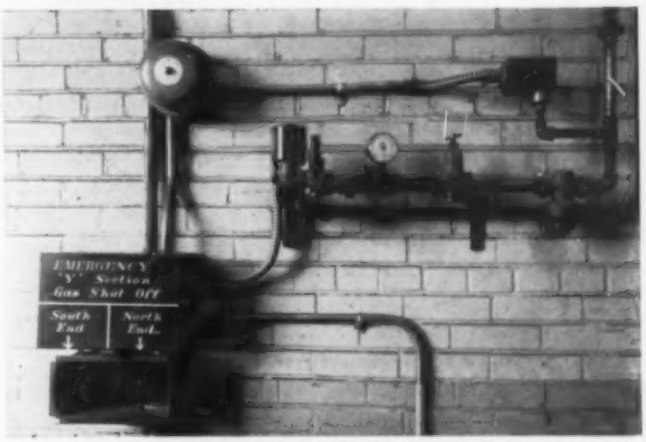


Figure 10 — One of the two shut-off stations. The alarm in the picture sounds in the event of an air pressure failure, and the solenoid air valve is connected "failsafe." It would therefore require a simultaneous failure of electric and air power to make the system inoperative without warning.

desired temperature is reached. It is a hydraulically-operated, self-contained unit, operating a butterfly valve in the fuel supply line by means of a hydraulic crank cylinder. When the pyrometer is calling for fuel, the unit acts as a pressure regulator. When fuel is no longer required, the pyrometer positions a three-way solenoid valve which actuates a transfer valve mounted on the regulator. This bypasses the regulator mechanism and closes the butterfly valve. A spring loaded hydraulic accumulator is connected in the system to make it "fail safe." It fully closes the butterfly valve in the event of a hydraulic pump failure. Since all of the hydraulic equipment is mounted on the furnace, a non-inflammable fluid is used.

In regard to temperature control it was felt that if a wide differential was maintained between the radiant tubes and the steel, a faster heat-up time could be achieved. With this thinking in mind, on-off control was specified, and two control points were selected. One point controls from the hairpin end of the radiant tubes, and the other from the lowest base temperature. The latter is accomplished by means of a selector switch. The thermocouples for obtaining the temperature of the inner bases are welded to the end of their protection tubes. They are inserted from the basement into a hole drilled in the hearth plate and held in contact by a spring at 25 psi compression. Only one pyrometer controls a furnace operation. It records eight points and controls from two points. Points 1,2,3, and 4 record the inner base temperatures. Point 5 records and controls the furnace temperature. The remaining three points are dots interspaced with the numbers. The three dots are printing from the same thermocouple and control the steel temperature. A manually-operated selector switch connects these dots to the lowest recording thermocouple. The contacts of the electrical relays for each control setting are in series so that each controlling thermocouple must be lower than its respective set point to open the fuel valve. A seting of 1575 F on the furnace temperature control point gives the greatest temperature differential consistent with economical tube life. A fan in each inner base recirculates the atmosphere gas at more than 1000 fpm velocity by the outside diameter of the stacked coils, assuming the coils are of maximum diameter. The gas flow is directed upward between the coil and inner cover. The fan is driven by a 16-hp motor. A separator blower cools the four fan motors on each base and drives a lubricator for them. Double-ribbed convector

plates are used between the first and second coils on three-high stacks, also between the second and third coil on four-high stacks. The inner covers are made of corrugated alloy steel. The inner cover sand seals were originally set at six in., but at this height sand was picked up and deposited on the coils by the recirculating gases. The sand seals were lowered to four in. and a coarser sand was used. This overcame the sand problem but resulted in a greater consumption of atmosphere gas.

The atmosphere gas used is DX gas and is produced by four generators having a total capacity of 50,000 cfhr. Natural gas is burned in these units to obtain the DX gas.

The generators themselves consist of a combustor, air pump, cooling tower, heat exchanger, refrigerating unit, and a recirculating pump. Air is blown by the air pump into the mixing chamber where it inspirates the proper amount of gas. The set ratio is controlled by the action of a zero regulator. Partial combustion exhausts the oxygen and the resulting DX gas is passed from the combustion chamber through a water cooled header to a cooling tower. Here water which was previously condensed in the refrigerating unit is sprayed contraflow to the passage of the gas.

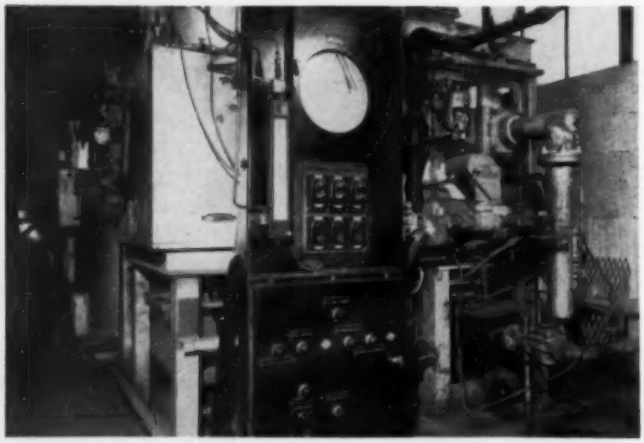


Figure 11 — Control panel for atmosphere gas generators shows the cabinet housing the relays and signal lights which form part of the electrical safety circuits.

The water falling to the base of the tower intermingles with the condensate and is pumped through the mill water-cooled heat exchanger and back to the sprays at the top of the tower. An overflow pipe on the tower drains away excess water.

Upon leaving the cooling tower the gas passes over refrigerated coils and drops out its moisture. Any entrained moisture is removed by an eliminator at the exhaust end of the condenser. The dew point is held at plus 40 F. The gas enters the header at a pressure of 20 in. water column and is piped to all the bases.

At each stack a regulator controls the DX gas pressure under the inner cover at 1-in. water column. Originally, the gas was piped directly into each stack from underneath. Recently, some of the feed lines have been changed to put the gas into the base through the recirculating fan motor housing. This can be done because the motor is sealed airtight and gasketed to the base. Gas passes through the motor windings, the top bearing, and then enters the base around the impeller shaft.

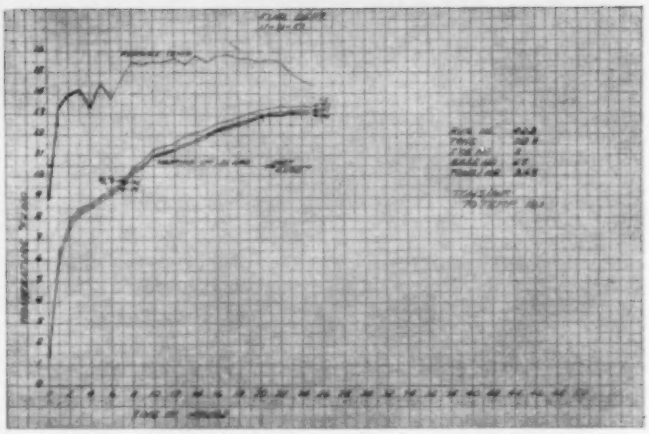


Figure 12 — This is a temperature curve of a typical run. The load was 212.8 tons, furnace temperature 1560 F, the work temperature 1300 F, was reached in twenty-one hours giving a heating rate of 10.1 tons per hour. The soak period was four hours.

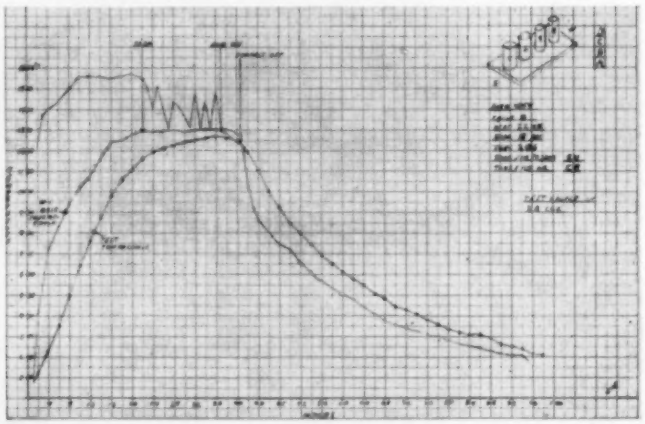


Figure 13 — Temperature curves taken with the test couples. The internal steel temperature never reached soak temperature.

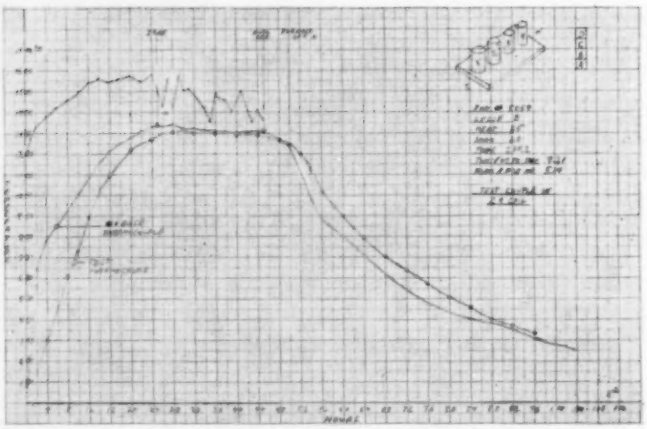


Figure 14 — In this case internal steel temperature reached soak temperature for a substantial part of the soak cycle.

This was done to prevent any infiltration of air around the seal between the fan motor and base.

The building in which the annealing facilities are located is 1080 ft long and 90 ft wide. It is served by four overhead cranes, two of which are equipped with dual hooks of 50-ton capacity for changing the furnaces, and a 25-ton auxiliary single hook. The other cranes have a main single hook of 25-ton capacity and an auxiliary of 10 tons. The annealing is tied into the

flow pattern by upenders and floor level conveyors which lead from the tandem and reversing mill and to the temper mills and flying shears. The annealing bases are located in two sections (21) bases at the south end and (20) bases at the north end, separated by a space of 120 ft, to provide for east and west flow of traffic. In each section there are eight annealing furnaces, one pyrometer room and several control rooms containing the switch gear for the bases. There are ten pyrometers in each of the two control rooms. The four extra pyrometers act as a safeguard against breakdowns, provide for maintenance, and also enable the heater to obtain a cooling curve of any base in which he might be interested. Thermocouple and control wires from each base terminate in a receptacle on a panel board adjacent to the pyrometers, and the wires from the pyrometers terminate in plugs on the same panel so that any pyrometer can be used on any base in that section.

In keeping with the safety policy of the Ford Motor Company, all controls were designed on a "fail safe" basis. For example, an entirely new thermocouple burnout circuit was designed for our installation. The circuit found on most pyrometers might not always work for us because of the wide difference in temperatures at the beginning of a run. The drift upscale was so slow that another thermocouple might be in the circuit before the 'open' couple could drift past its control point. Also, in the line of safety, power operated shut-off cocks in the main fuel lines to the annealing facilities were installed. These shut off valves can be controlled from two remote stations. They are designed so they can be shut off under power, but cannot be opened until the power is removed, and then only manually at the valve itself. This in no way interferes with shutting the valves off by hand in the usual manner.

Protection was provided on the DX generators by an electrical circuit which would sound a siren upon failure of any important function. A panel light would locate the failure. However, the condenser unit for each generator is piped so as to be interchangeable with this unit in any other generator. It was determined that an unsafe condition could occur while a condenser was being used on a generator other than the one on which it was installed. Therefore, a new electrical circuit was designed and installed to correct this condition.

As soon as our annealing facilities were put into operation, temperature tests were conducted to determine proper soak cycles. The following is the method used for obtaining internal coil temperatures. In the past, a scrap coil was obtained and holes drilled to various depths in which thermocouples were inserted. However, in analyzing results, there was reason to suspect that the heat was flowing lengthwise down the thermocouple and causing the hot junction to indicate temperatures above that of the steel.

A thermocouple was assembled that could be wrapped in the strip by inserting it from the side as it was recoiled on our skin pass mill or while being coiled after reduction on our tandem mill. This thermocouple was made of No. 20 gage wire laid parallel about ½ in. apart and sewed between four layers of asbestos tape. When wound in the coil, about four in. of it was allowed to project. After the coil was placed on the annealing base, thermocouple lead wire was welded to it and brought out of the base in the usual manner.

The present fuel rate is about one million Btu per ton, with a heating rate of ten tons per hour on loads of over 180 tons. The tons per furnace hour will naturally vary with the product mix. Based on present practice of about 50 per cent commercial and 50 per cent deep draw quality, records show 6.1 tons per furnace hour.

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Figure 1 — Extensive corrosion is indicated by the large fragments of scale which have spalled off the building column.

. . . . constant development is taking place in improving coatings for use in corrosive environments . . . . a number of recommendations for steel plant applications are given in this paper . . . .

Protective Coal Tar Coatings in Steel Plants

By W. F. FAIR, JR.
Tar Products Div.
Technical Dept.
and
H. J. CIBULA
Sales Representative
Tar Products Div.
Sales Dept.
Koppers Co., Inc.
Pittsburgh, Pa.

▲ BEFORE discussing protective coatings, attention should be given to the degree of importance in the use of such coatings. Considerable evidence is now available demonstrating that the sound use of properly applied, suitably formulated protective coatings cannot be over-emphasized.

It has been estimated that rust and corrosion cause an annual replacement cost of $6,000,000,000. Much of this loss is unnecessary and can be prevented at sensible costs in most of the generally encountered corrosive situations.

A few years ago we were called in to advise a customer on the best means of mitigating corrosion in a heavy chemical plant. Corrosion was extreme in this plant due to vapors of hydrochloric and sulphuric acids, as well as general marine atmosphere conditions. Three buildings had become completely unfit for manufacturing use. They had been idle for some time and no maintenance or protective measures of any kind had been taken, hence these buildings were a complete loss. We obtained permission for use of pictures for educational purposes showing the extent of the corrosive destruction. Figures 1 through 3 illustrate these conditions and the necessity for the demolition of the structures.

Figure 1 shows a heap of large fragments of scale and iron oxide which had spalled off the steel supporting column. Figure 2 shows a typically badly rusted perforated beam. Figure 3 illustrates the corrosive damage and perforation in channels and I-beams.

Adequate steps were taken immediately to keep the other buildings at this location in satisfactory safe operating condition.

PLANNING AND DESIGN

A great deal of the trouble encountered in corrosion prevention starts with faulty planning of the initial project. Seagren[1]* has pointed out that: "It is not necessary that a design engineer be familiar with all

Figure 2 — Beams, rusted as shown, necessitated demolition of building.

* Numerals refer to Bibliography at end of article.

Figure 3 — Extensive damage from corrosion is readily apparent.

types of organic coatings, but it is highly desirable that he have an understanding of the fundamental corrosion processes and of the mechanics of corrosion prevention by means of organic coatings. Equipped with such information the engineer will consider corrosion prevention as another problem in design. Too frequently corrosion protection is only a necessary afterthought. Many of the difficulties with which organic coating technologists are confronted might have been avoided on the drawing table." Types of construction practices which should be replaced wherever possible are sharp edges, angles, bends, corners, metal lace-work, grooves, depressions, thin structural supporting members, and the like. Figures 4 and 5 illustrate some of these undesirable installations, examined by the Steel Structures Painting Council. Figure 6 shows the type of test panel favored by the SSPC to evaluate coatings in different environments. It should be noted that on the small area of this panel are reproduced the structural combinations which are extremely difficult to protect, namely welds, weld spatter, spot welds, rivets, laps, crevices, angles, cornices, pockets, and sharp edges.

Additional evidence concerning the savings to be expected by proper design and choice of coatings is given in a paper by Stirling[2].

Parker[3] describes the advantages of joint use of coatings and cathodic protection in general, and Johannsen[4] and Coe[5] have written on the installation of cathodic protection and coatings, respectively, in steel plants.

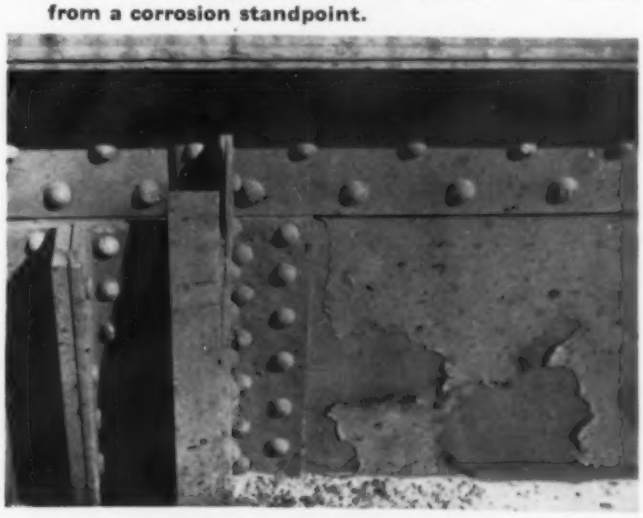
SURFACE PREPARATION

No matter what type of coating is used to protect a metallic surface, it is absolutely essential that all surfaces be thoroughly cleaned before application of the coating. Frequently differences in quality between coatings of widely different price ranges are completely masked, and the expected beneficial effects of conventional or special coatings for a particular installation are lost because the surface has not been properly prepared.

Some years ago, Seagren[6] emphasized the importance of adequate surface preparation and pointed out that an increasing number of coating or formulating companies will not sell their materials for unsupervised application by any purchaser. He quotes Lieutenant R. B. Strode, "The preparation of the metal surface is of vital importance in order that a completely satisfactory finish may be obtained. Without it no paint can provide the desired durable finish."

Figure 4 — Factors which lead to corrosion can be reduced by proper initial design of the structure.

Figure 5 — Sharp angles, corners and pockets are harmful from a corrosion standpoint.



The surface should be completely free of moisture, mill scale, welding scale, rust, grease, dirt, and corrosion products or any other foreign matter.

Mill scale, a complex mixture of iron oxides is highly corrosive resistant, but unfortunately is brittle and subject to cracking, making it unsuitable for coating application. Therefore, the complete removal of mill scale is now universally recommended. Sometimes this removal is effected by weathering, after which the loosened scale may be removed more easily.

The removal of oil and grease, if present, is usually accomplished before mechanical cleaning of the surface. Solvents, such as mineral spirits, xylol, or solvent naptha, may be used, or vapor degreasing may be employed to obtain a clean surface. It is necessary at all times to provide adequate ventilation. Steam cleaning, using detergents, is frequently practiced to remove surface contaminants.

Brushing, scraping, grinding, chipping, and blasting are methods which have long been used to remove old paint coatings and to clean the metal surface. Chipping is reported to produce bad after effects and is no longer recommended. Blasting by sand or by shot is probably the best method for removing mill scale and other contaminants. Unless the shot can be recovered, it is more economical to use sandblasting. Whenever blasting is used, the surface will be etched providing excellent tooth for the first coat. After blasting, the surface should be brushed or cleaned by blowing and immediately coated before the chemically active blasted surface starts to form rust. Frequently rust inhibitive washes containing small amounts of chromates, dichromates, or phosphoric acid are applied prior to the prime coat to delay incipient corrosion and to provide better adhesion for the subsequently applied coating material.

If acid pickling is used, it is necessary of course to remove the acid and dry the surface quickly and completely without formation of oxide. Care should be taken also to avoid the effects of hydrogen diffusion. Hydrogen can be absorbed to a surprising extent by steel, and then may blister a subsequently applied coating under moderately high service temperatures. After pickling, washing, and drying, it is therefore considered good practice to heat the metal to a temperature well above anticipated service conditions to free adsorbed hydrogen and thus avoid later destruction of the protective coating.

Flame cleaning is sometimes used to remove scale and other contaminants. This is done by passing an oxyacetylene flame over the surface at a speed of about 10 to 20 fpm. The heat removes scale and other solids by difference in expansion; vaporization of moisture facilitates the removal. Immediately afterwards, the surface should be vigorously wire brushed to remove

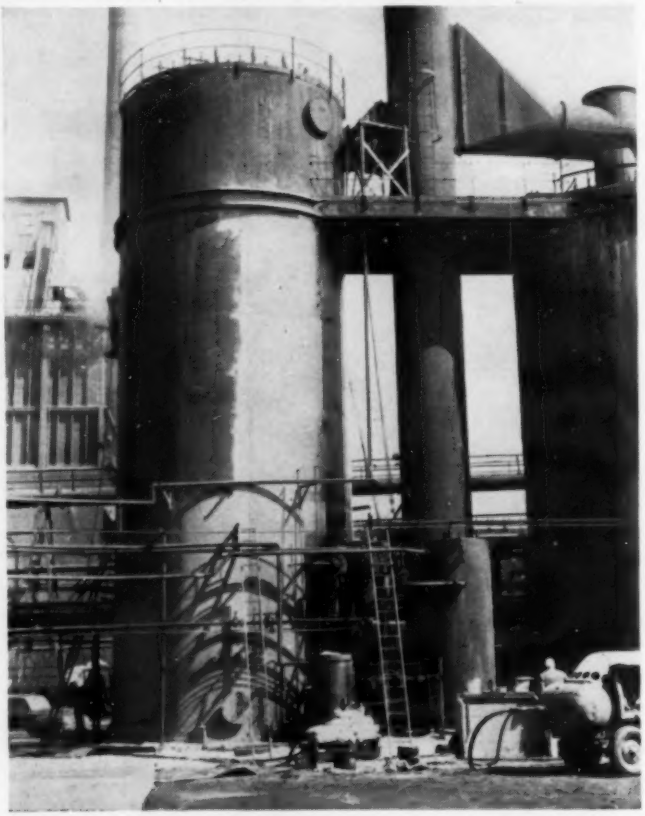


Figure 7 — Sand blasting is a very effective method of preparation for painting.

Figure 8 — The surface obtained by sand blasting is illustrated in this photo-micrograph.

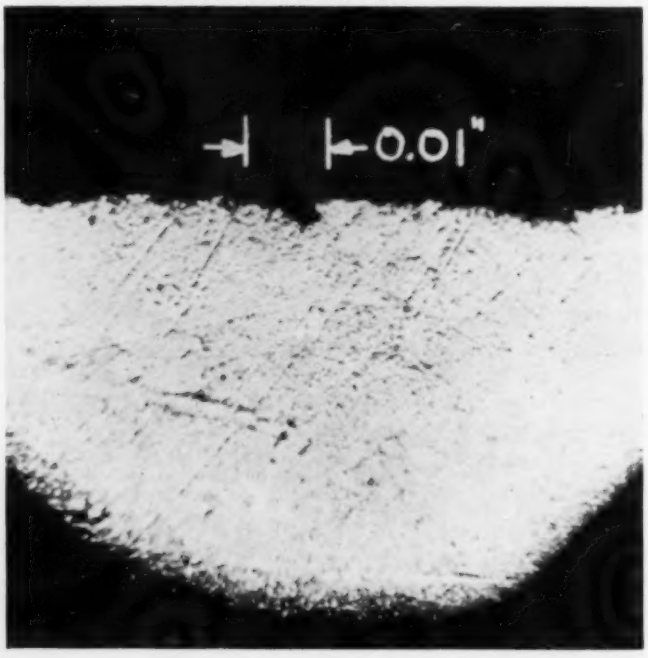
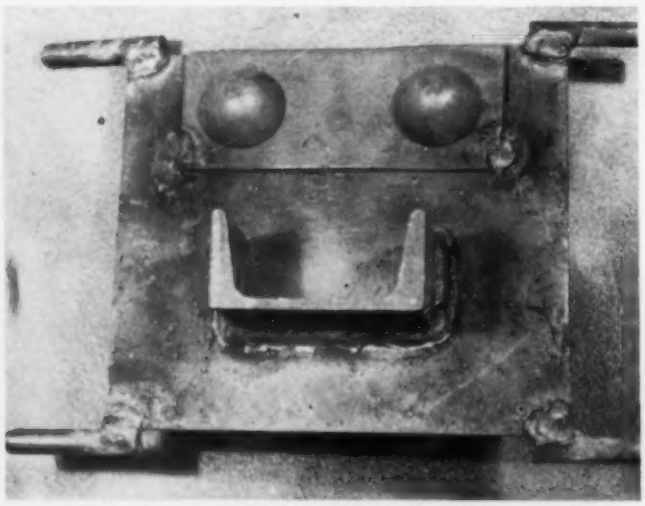


Figure 6 — The SSPC favors this test panel for coating evaluation.



dust and loose particles. Again the first coating application should follow as soon as practical after flame cleaning. Thermoplastic coatings will exhibit improved bond if applied before the metal surface cools; frequently applicators heat clean surfaces to effect such improvement in adhesion.

Additional detailed information on surface cleaning methods has been provided by Liebman[7].

If wash primer, as described by Whiting[8] is specified, it should be considered as part of the metal surface conditioning and not as the "primer" for the coating system. This product, which serves as an inhibitive wash coat and temporary anti-corrosive primer, is an alcohol solution of polyvinyl butyral, pigmented with insoluble zinc chromate, with phosphoric acid being added before application. Wash primer dries quickly and may be applied even to moist surfaces, provided the latter are clean. Coal tar coatings may be applied on wash primer, which is usually specified if for any reason the selected coating cannot be applied quickly enough to the cleaned chemically-active surface, or if the surface can be cleaned satisfactorily, but not well dried. It should be noted that wash primer does not replace the primer of non-bituminous paint systems.

Figure 7 shows a 20-ft diameter tank during sandblasting. Figure 8 is a photomicrograph of a cross section of a sandblasted surface, showing the desirable tooth here obtained.

COATING PROPERTIES AND ENVIRONMENTS

In selecting the proper coating for a particular installation, the first consideration should be given to the corrosive environment. Various degrees of corrosivity ranging from very mild, such as might be found in an arid or inland rural location, to extremely bad, such as in a southern humid coastal industrial section, may be encountered and should govern the specification of a satisfactory coating. Obviously, the coating system specified should have adequate resistance for the particular corrosive environment, at the lowest cost of materials and application.

The properties of the coatings themselves should also be considered. At the time of application, the adhesion and viscosity of the coating must be suitable to provide the proper thickness and subsequent adherence to the coated surface; also, the film must prevent corrosion and have a suitable drying rate. The dried coating must have satisfactory adhesion throughout the range of service conditions expected and must have appropriate flow properties to provide permanence on the surface, adequate thickness, impermeability, elasticity, and satisfactory weather resistant properties. Occasionally appearance may be of importance and must be taken into consideration.

To insulate the metal surface from the corroding environment, a heavy duty, long lasting, effective coating must characteristically exhibit insignificant water adsorption, high and permanent electrical resistivity, and resistance to spillage, and be capable of application at appreciable thickness, of the order of several mills per coat. Coal tar products have these required properties to a marked degree. Their low water absorption

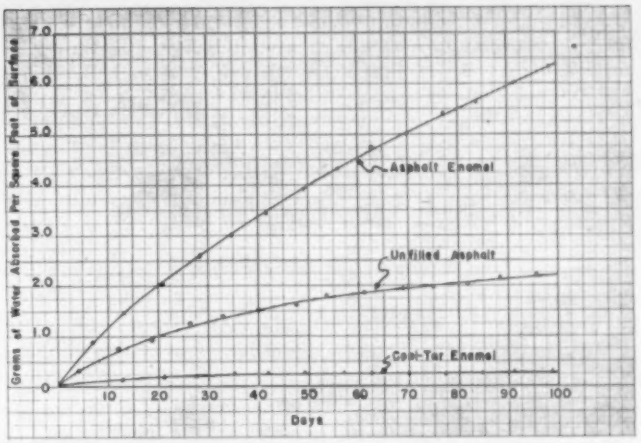


Figure 9 — Water absorption of several coatings is given in this chart.

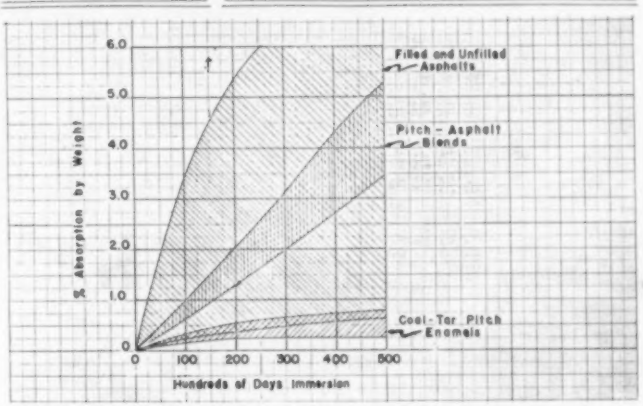


Figure 10 — Test results are given for water absorption of bituminous coatings.

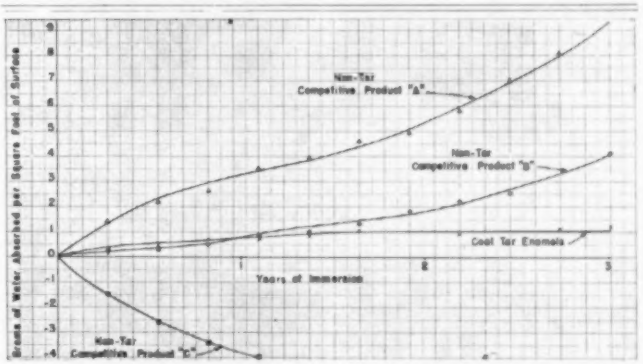

Grams of Water Absorbed per Square Foot of Surface
Non-Tar Competitive Product "A"
Non-Tar Competitive Product "B"
Coal Tar Enamels
Years of Immersion
Non-Tar Competitive Product "C"

Figure 11 — Chart shows a comparison of water absorption of commercial coal tars and non-tar pipe line enamels.

over long periods of time has been amply demonstrated. Figure 9 shows data published by Hayes[9] of the Los Angeles Water Department.

Similar results are presented in a chart, Figure 10, furnished through the courtesy of the Barrett Division of the Allied Chemical & Dye Corporation. Recently acquired data, covering longer periods of test by immersion in water, are given in Figure 11 covering coatings available today. Some non-coal tar coatings are found here to exhibit low water absorption initially, but to change markedly in this important feature with time.

The volume resistivity of coal tar enamels is of the order of 10^{14} to 10^{15} ohms per cubic centimeter. Equally important is the fact that these high values do not drop with time of exposure. Laboratory samples

still have this value after eighteen months total immersion in water.

Laboratory tests and field experience have proved conclusively the resistance of coal tar coatings to many kinds of solvent and oil spillage. These coatings, depending upon the type selected, may be applied in thicknesses of 10 to 100 mils per coat.

COAL TAR COATINGS

This class of protective coatings which may be divided into hot and cold applied types, has a long history of entirely satisfactory performance under severe exposure conditions.

HOT APPLIED ENAMELS

The thermoplastic coal tar enamels are usually procured under specifications containing softening point, penetration, ash, high temperature sag, and low temperature embrittlement test items. The ranges adopted for these properties have been selected as the results of decades of application experience and service performance. They do not in themselves constitute performance guarantees, but they do insure that coal tar coatings meeting the required specifications will be equivalent to the same basic type of coating previously found satisfactory for the environment encountered, and known to have the general fundamental characteristics described above.

It should be emphasized that any new protective coating cannot be evaluated by these specification tests. Any such untried products must be subjected to long term laboratory tests, and simultaneous field trials under service conditions. This is particularly important if immersed or underground service is under consideration.

For nearly 100 years coal tar enamels have been used to protect the internal surfaces of iron and steel ships against severe corrosion, particularly for surfaces either inaccessible after construction or wet and damp so frequently that repainting is impractical without dry docking the vessel. These coatings have also been used extensively on dry docks. One example of extremely good performance was recorded on a dock built in England in 1892 and scrapped in 1938. The enamel was reported to be in perfect condition after 46 years service, under the severe corrosive environment of alternately wetting with sea water and drying in the atmosphere.

In more recent years enamels have been used for other types of installations where heavy protective coatings were needed to withstand severe corrosive conditions. In 1913 enamel was used on an experimental application on a penstock for an hydroelectric company. Twenty-six years later inspections indicated that the coating was still satisfactory and exhibited no tubercles, blisters, or rust.

In 1914 enamels were first used to protect underground large diameter steel water pipe. Tests were considered sufficiently satisfactory six years later to call for the specification of enamel throughout many water supply systems.

In the period 1926 to 1930, engineers specified enamel coatings for many of the natural gas pipelines built in that period. Since then coal tar enamel coatings have been used extensively to protect such lines against soil corrosion, and have also been applied to oil lines and product pipe lines.

In his excellent papers, O. C. Mudd[10] discusses corrosion control, and points out the desirability of cathodic protection and the best methods of installing cathodic protection. He concludes that counter-current protection, in combination with coating, constitutes the most economical and effective means of giving pipelines their required service life.

The coal tar enamels should be applied to clean surfaces, and the surface should be primed with an appropriate cold applied coal tar material before applying the molten hot metal. Simultaneously, with the application of the hot enamel, a spiral wrapping of glass fiber of suitable thickness, or a 15-lb coal tar saturated asbestos pipeline felt or of both, is applied to reinforce or shield the enamel.

The enamels are of two general types, plasticized and unplasticized. The former has a wider service temperature range and is preferred over most of the country; the second type is usually specified where there is little danger of encountering sub-freezing temperatures. An intermediate type is preferred by some engineers.

In a paper presented at the 1951 Annual South Central Regional Meeting of the National Association of Corrosion Engineers, Mr. N. T. Shideler of Pittsburgh Coke & Chemical Company, presented a table to indicate the various trade names of enamels available in these three grades. See Table I.

TABLE I

Manufacturer	Commercial coatings narrow range enamel	Moderate range enamel	Wide range enamel
Barrett Company	180-190 F pipeline 190-200 F pipeline	Millwrap	Waterworks
Koppers Company	XXH Enamel XXH Free flowing enamel	"Bitumastic"* Special No. 2	"Bitumastic" 70-B "Bitumastic" 70-B free flowing
Reilly Tar and Chemical Co.	Pipe line enamel	.....	230 F Enamel
Hill, Hubbel Company	.....	Biturine Aqualine	.....
Pittsburgh Coke & Chemical Company	Standard	Modified	Plasticized

*Registered Trademark

After application, the coating and wrapping are tested by a holiday detector, an electric device which is moved along the coated pipe, after cooling to pick up any missed spots, pinholes, or holidays. Such weak spots, after detection, are then repaired before being subjected to regular service.

Steel water pipe may also be treated both internally and externally with coal tar enamels to protect the pipe from corrosion and tuberculation, which otherwise is liable to cut down the velocity of the water tremendously. The enamel is usually applied in yards where it is customary to white wash the entire outside surface of the coated pipe and the ends of the interior lining. This is done to reflect sunlight and thus keep the coating from getting too hot when later exposed along the right-of-way before burial. The molten lining material is introduced by a trough which is inverted to pour the hot enamel lengthwise along the revolving pipe. The centrifugal force developed by the spinning pipe together with the proper viscosity obtained by the application temperature of the lining material, causes the latter to flow evenly and adhere tenaciously to the previously primed surface. An extremely smooth surface may be obtained in a pipe coated with spun enamel.

Besides the permanent protection afforded against tuberculation and corrosion, both inside and out, another important advantage of the spun enamel lining is its sustained high flow coefficient. The New England Water Works Association has assigned the following values for the Williams & Hazen coefficient:

Spun enamel lined pipes, supply and transmission mains

16-in diam and larger . . . A C-value of 155

Distribution mains, enamel lined,

Less than 16-in diam . . . A C-value of 145

This initial high flow coefficient does not change and therefore, it is not necessary to use oversized pipe to take care of expected reduced capacity from future tuberculation, which so often occurs with some other types of pipe. As the flow capacity is directly proportional to the flow coefficient valve C, it is evident that flow through the enamel lined pipe with the above assigned valves, will be 45 to 50 per cent greater than a pipe which drops to a C value of 100, a figure frequently used in determining pipe sizes. With the improved flow properties, there is also an attendant reduction in the cost of operation, resulting in savings in fuel and power.

The particular type of enamel to be used for a specific installation depends to a great extent upon the type of service expected and upon conditions which vary in different parts of the country and between different industries. Proper selection should be made by competently qualified engineers. If any questions arise as to the suitability of the proposed coating, it is advised that the manufacturers of the coatings be consulted.

COLD APPLIED COATINGS

Frequently, it will not be convenient to apply hot coatings or for other reasons the customer may restrict the protective material to cold applied types. To provide heavy duty cold applied bituminous coatings, several manufacturers now produce a comprehensive line of such coatings covering a wide range in viscosity and recommend installations.

The thinner coatings may be applied by brush or pressure pot spray; the more viscous coatings intended for very heavy duty and applied at relatively great thicknesses, either have to be brushed or daubed on, or applied with positive pump pressure.

Approximately equivalent products are manufactured by four or more individual competitors, although few producers offer all the types discussed. Information about products made by different manufacturers, can be obtained from their technical departments, district sales offices, or distributors. It is, of course, necessary to clean the surface to be protected, as emphasized above, before application of the selected coating.

These cold applied coal tar base protective coatings may be summarized by separation into the following classes:

1. A relatively fluid pitch-solvent cutback, intended for light to moderate corrosive environments, providing high coverage at a rate of approximately 400 sq ft per gal per coat.
2. A filled more viscous solvent cutback type, suitable for heavier application and more severe environments, usually applied at a rate of 100 to 150 sq ft per gal per coat. Care should be taken to make sure that a non-settling product is procured, when this type is under consideration.
3. A filled, heavy duty, high consistency thixotropic solvent cutback intended for extremely severe corrosion environments, applicable at a rate of approximately 55 to 70 sq ft per gal per coat.
4. A high consistency, thixotropic, filled acqueous dispersion of coal tar pitch, intended for heavy application at a rate of about 50 sq ft per gal per coat, particularly suitable for extremely corrosive atmospheres. Primer recommended prior to application of this emulsified coating.
5. Another type required by many consumers is a cold applied coal tar coating which can be used in water lines, water tanks, air conditioning ducts, and the like to protect the metal surfaces without imparting taste or odor to potable water or interior atmospheres. This fluid coating made with selected pitches and special solvents to meet the above requirements, may be applied at a rate of approximately 400 sq ft per gal per coat.

Generally speaking, all the above coatings should be applied in at least two coats; sometimes a third coat is specified for particularly damaging environments.

The residual films left by evaporation of the solvents from these coatings are all chemically inert and resistant to water vapor, moisture, fumes, rain and sunlight, and many types of petroleum and other kinds of oil spillage.

Except for the emulsion, the above listed coal tar coatings are all self-priming; the manufacturers usually recommend that these types of coatings be applied to the clean bare metal directly, immediately after cleaning. Not only should it be noted that in general primers are not needed to effect good adhesion of the dried film to the metal surface, but in many instances they may

cause poor adhesion and rapid failure of the coating system. The solvents necessarily used to dissolve or disperse coal tar residuals in making these coatings have to be of a highly aromatic, high solvency type. When coatings containing such solvents are applied in thicknesses such as mentioned above, which in the case of the heavy duty, high consistency materials will provide films of the order of 20 mils per coat, the solvents evaporate very slowly from such thick films, and hence contact any previously applied dry primer for considerable lengths of time.

We, and presumably many others, have cooperated with technical personnel employed by various manufacturers of conventional paints, and have not been able to develop a non-bituminous primer safe from attack by these solvents, except as noted below.

The more fluid coal tar solvent cutbacks which are applied at high rates of coverage, and hence have relatively thin films, hardly more than the thicknesses usually obtained with conventional paints, may be used with previously tried and selected non-bituminous primers such as red lead primers having vehicles which are formulated to be high in resins and low in oil.

Another exception may be found in the use of coal tar emulsions or dispersions over certain non-bituminous primers. If an inhibitory pigmented primer is desired, it should be tested in combination with the particular emulsion under consideration; it is quite likely that the emulsion, which should contain no high solvency solvent, will adhere to the primed surface without undesirable softening of the film left by the primer. Otherwise, a cutback tar primer or one of the self-priming coal tar coatings should be used under the emulsion.

The solvent attack on the primer residual film usually results in softening of the primer film and slippage of the topcoats or of the entire protective coating system.

Recently another type of inhibitory pigmented primer which may have possibilities for use in combination with coal tar top coatings, has been under consideration. These are the epoxy formulations which appear to be far more resistant to the high solvency cutbacks, than are the phenolics, alkyds, and vinyls previously tested. To make use of the resin formation to provide a primer film, the epoxy vehicle is mixed with an amine catalyst just prior to application. The catalyst increases the speed of polymerization, resulting in formation of the desired hard resinous film. Prevailing temperatures have a great influence on the catalytic action and final properties of the applied coating. Of the many formulations tried in combination with heavy duty, heavily applied coal tar coatings, certain epoxy resin formulations give promise of satisfactory compatibility with coal tar products.

When a shop coat is desired to protect structural members during shipment and storage, prior to field coating, the advice of the coating manufacturer on the kind of coal tar base shop coat recommended, should be carefully followed.

It should also be noted that many of these bituminous coatings tend to alligator upon exposure to intense sunlight and attendant black-body temperature rise. It has been found that pitch emulsions not only do not alligator when applied alone in two or more coats, but also provide non-alligatoring protection, when applied over the heavy duty thixotropic cold coatings, or even over hot applied coal tar enamels, either of which dual systems offers the best in long lasting protective combinations for the most severe atmospheric corrosion environments.

Three other coatings are offered by some manufacturers as auxiliary protective coatings to provide complete industrial plant coverage. One of these special products is formulated on a coal tar base; the other two have non-bituminous vehicles.

The tar base coating was developed at the request of railroad maintenance engineers who wanted a durable weather proof topcoat to seal creosoted bridge and cross ties and prevent entrance of water, sand, or stones into cracks formed by the mechanical pounding and damage to the wood structure. This product has given excellent service for upwards of eight years on main lines. It is recommended that small cover stone be cast on the wet coating to provide a weatherproof "roof" for the tie. Although this product is a cutback, it has been so formulated as to reduce the fire hazard which might otherwise be expected with this type of compound, especially at the time of application. This development may be of interest to steel plant maintenance engineers.

Of the non-bituminous products, one is a high temperature gray paint, metal pigmented, designed for application to stacks and other such surfaces. It should be applied at moderate temperatures, and then brought to at least 500 F before any appreciable amount of weathering can occur. The other, an aluminum pigmented paint, in a varnish vehicle, is recommended for

Figure 12 — Atmospheric conditions have a very important effect on coating life.

use over the emulsified coating as a topcoat where high reflectivity is required, or as a seal coat, if a conventional color paint is to be applied later.

COAL TAR COATINGS IN STEEL PLANTS

To provide specific information on the use of these coatings in steel plant corrosion mitigation, inspections were made recently of four major steel plants where various of these coatings and combinations of coatings had been previously applied and exposed under service conditions for different periods. Figure 12 shows a typical scene illustrating the corrosive fumes generally encountered. Below are given descriptions of the systems and results obtained at these four locations.

Plant I—In 1949, two blast furnaces, eight stoves, two skip hoists, all wind and gas piping, structural steel of both cast houses, and all other appurtenances were coated with two coats of coal tar cutback coating of the second class described earlier. Previous paints were 50 per cent gone in the cast house in 18 months, and were 20 per cent gone on the other structures in three years. An inspection in May, 1955 after six years service, showed that the coating was still providing protection to 90 to 95 per cent of the metal surface. Within the next year, these furnaces are scheduled to be recoated with the same coating. Obviously, the area needing cleaning to bare metal prior to recoating is relatively small, and therefore, the surface preparation can be accomplished at low cost with minimum effort.

Figure 13 shows a general view of this area; Figure 14 shows the siding of the cast house, the cold blast main, cold blast main supports, blast furnace gas main, stoves and furnace skip hoist of one blast furnace after coating.

Figure 13 — Effective use of bituminous coatings has been made in blast furnace areas.

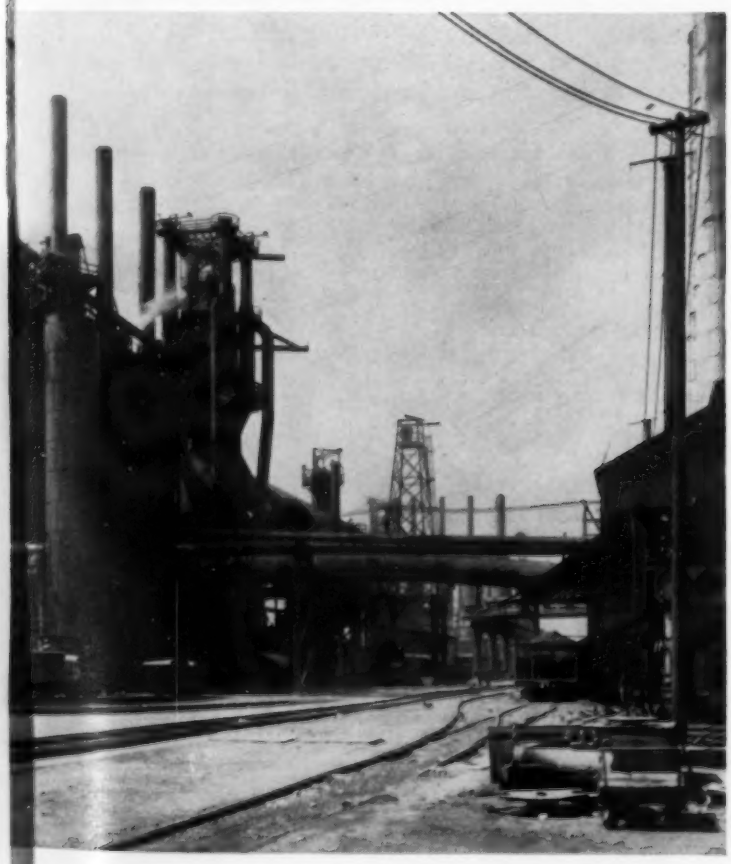


Figure 14 — Piping shown in this view has had its coatings in service over six years.

Plant II—In 1949, the blast furnace trestle was coated, after wire brushing and scraping, with two coats of the Class (2) type, above. When inspected in May, 1955, the coating was still 90 per cent intact. Previous coatings had deteriorated 20 to 30 per cent in two to three years. Figure 15 shows a portion of the trestle.

In the same year, the cold blast mains in this plant were wire brushed and scraped, and then coated with a thin coal-tar primer followed with a heavy coat of coal tar emulsion coating of Class (4). Figure 16 shows this main after five years service. In May, 1955 this coating was still 97 per cent intact. Due to the quenching station mist and other conditions prevailing in this area, all previous coatings on this line had failed within two years.

In 1952, the metal pigmented, high service temperature oil base paint described above was applied to a blast furnace gas washer intake pipe. This coating was still in excellent condition in May, 1955. Normal paint life hitherto had been only 30 days before complete failure of the film at this location.

The sheet piling bordering the dock areas were coated in place, above the waterline, after driving, with two coats of Class (2) cold coating. This was finished early in 1952. No coating deterioration could be observed when examined in May, 1955, three years later. Previous coatings in this service lasted only through one winter due to the scouring action of ice, logs, sand and other debris which removed most of the coating for three feet or more above the waterline.

Twenty-one thousand squares, or 210,000 sq ft, of asphalt-asbestos protected metal on a bar mill roof were coated in 1953 with Class (2) cold coating. This roofing was all over ten years old. The top asphalt coat-

ing had weathered off, leaving the asbestos envelope exposed and needing reimpregnation and sealing. On inspection two years later, this roof was in perfect condition.

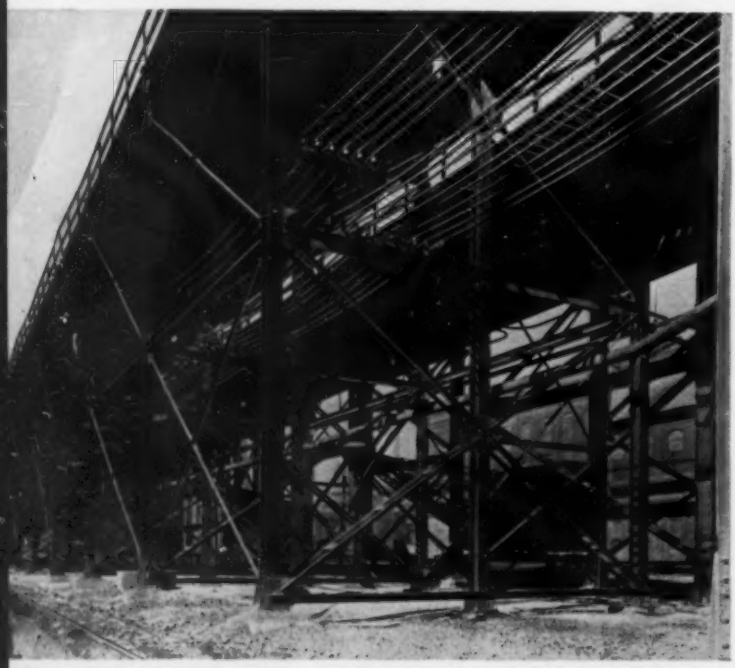
The same type of roofing material, installed in 1940 over the heating furnaces of the strip mill, was brushed down and rejuvenated in 1951. Class (2) cold coating was applied to 500 squares in this instance. Also, in 1951 identical corrective measures were specified for 1000 squares of roofing of the same type which had been installed some ten years previously as roofing for the motor room. Both recoated areas were in perfect condition in 1955.

Approximately 3000 ft of 24-in., 36-in., and 48-in. diam piping carrying scrubbed coke oven gas was coated and lined with coal tar primer and coal tar emulsion, Class (4) cold coating. These pipes are all above ground and were coated and lined in 1952. As of May, 1955, coating was 99.9 per cent intact on exterior surfaces.

All underground steel water lines in this plant are coated and lined with coal tar enamel complying with the American Water Works Association's Specifications.

Plant III—This plant was built where a generally mild climate and weather conditions prevail. When it was decided to recoat virtually the whole coke plant in a comprehensive maintenance and repair program, it was not necessary to be concerned with sub-freezing temperatures or sudden temperature changes in specifying the coating for this plant. This large-scale program of recoating was necessitated by the complete failure of the conventional paint systems previously applied. Specifications called for sandblasting all steel to clean metal followed by the immediate application of one heavy coat of coal tar coating Class (2). When this was completely dry, another application of the same coating was made, and finally topped with coal tar emulsion of Class (4). This system was specified for all of the following areas.

Figure 15 — Areas such as this shown are a difficult problem for application of paint.



One 50,000-cu ft gas holder including all structural steel work.

One ammonia liquor tank including ladders and hand rail.

Three conveyors, 310-ft, 225-ft, and 277-ft, respectively, in length including all bents and supports.

Battery steel work including benches, bench supports, platforms, stairs, hand rails, end buckstays, miscellaneous small structural steel.

Collecting mains for two batteries.

Flushing liquor piping, 8-in., 12-in., and 16-in. in diam, including bridges and supports.

Gas mains in by-products areas which were not in buildings or underground.

Two pusher machines.

Miscellaneous piping not underground or not insulated.

Miscellaneous tanks of various capacities.

The above areas required a total gallonage of 7400 gal of Class (2) and 3000 gal of Class (4) coatings; over 200 tons of sand were used for blasting.

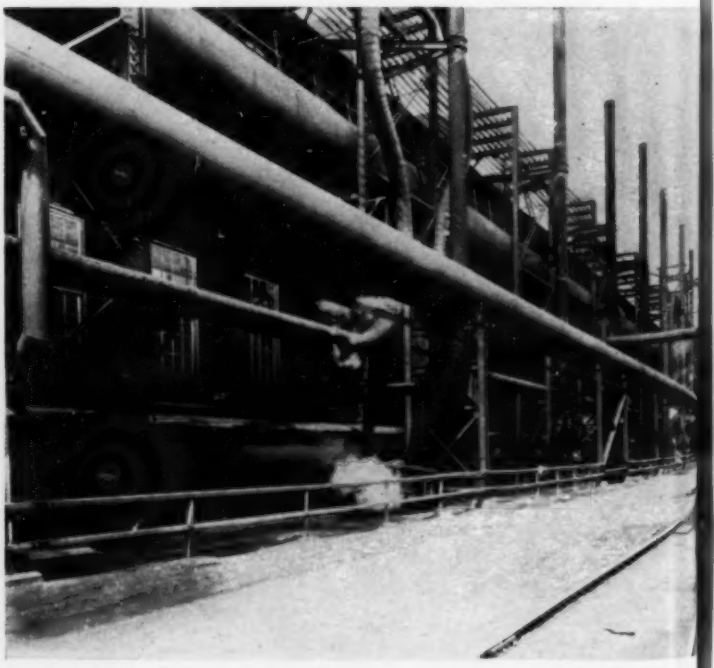
In addition, some other tanks used for storage purposes of materials kept at slightly elevated temperatures were insulated thermally from the atmosphere with a new medium-temperature, coal tar base, cork-filled insulating compound. A total of 3000 gal of this material was applied at the rate of five sq ft per gal to give a finished dry thickness of approximately ¼-in.

All of this coating was applied in 1953. Inspection in May of 1955 showed no deterioration of the coating beyond a small amount of mechanical damage.

Plant IV—When a battery and part of the by-product section of this plant were rebuilt in 1954, it was decided to put the best protection possible on the new steel work. All steel surfaces were sandblasted to clean metal before coating as described below:

Battery steel work—End buckstays, bench steel and supports, walkways, and platforms, received two coats

Figure 16 — Main shown here has had its coating in service for five years.



of Class (2) coating followed by one coat of Class (4) emulsion coating.

Collecting main, suction main, gas mains, and supports were coated with two coats of Class (2) followed by one coat coal tar emulsion Class (4).

Tar decanter, flushing liquor lines, supports were also coated after sandblasting with two coats Class (2) and one coat Class (4).

Final cooler, wash oil scrubbers, primary coolers, were similarly coated with the same multiple coating system.

Sheet piling at dock, coated, after sandblasting, before driving, with two coats cold coal tar coatings, Class (3). Topcoated above water line with one coat coal tar emulsion Class (4).

(In connection with the last installation, steel plant corrosion engineers will be interested to learn that test driving and subsequent pulling of coated piles, performed under the supervision of governmental technical personnel, demonstrated that less than ½ of one per cent of the coated area was damaged.)

Steel sash, coated with three coats cold coal tar coating Class (1).

In the eighteen months since installation and this year's inspection, no evident deterioration has occurred other than that caused by mechanical or accidental damage.

HOT APPLIED ENAMELS

The above descriptive material has all dealt with the application and performance of cold coal tar coatings which are normally used in areas that are accessible for maintenance and repair. All of the above four plants and many similar ones have standardized on the use of hot applied American Water Works Association's specification for coal tar enamel for subsurface and other inaccessible locations. All water lines are protected inside and out with this product, the specification for which requires a coal tar product and permits the use of no alternates. The same material is used as a coating for underground gas mains and to coat and line effluent pipe lines, provided the temperature does not exceed 120 F. Steel sewerage lines receive the same protective coating; concrete sewer lines are protected from acid sulphur gases by a heavy application of cold coating Class (2). Underground steel tanks are usually protected with coal tar enamel, or alternatively with two or three coats of cold coating Class (3).

For small diameter lines, underground, 8-in. to 14-in. diam this enamel may also be used as a protective coating, but it is more difficult to apply as a lining. Short lengths may be lined with enamel by damming, pouring, and spinning. For smaller diameter pipe, a special cold applied coating of Class (5), formulated to leave a tasteless and odorless residual film on the interior of the pipe, is frequently specified. It is recommended that applicator companies or coating manufacturers be consulted before establishing specifications for any small diameter water pipe installations.

For above ground large diameter water lines, the same enamel is used for coating and lining, with protection against alligatoring being provided by an application of a top coating of emulsion Class (4). Smaller

TABLE II

Coal Tar Coating Guide — Steel Plants

STRUCTURE –	Preferred system	Alternate
Below ground:		
Water lines	AWWA primer, AWWA enamel, for lining and coating; felt wrapper.	Two coats Class (3) exterior only, glass and/or felt.
Water lines 8 to 14-in. diam.	Same as above (short-length).	Same as above.
Water lines under 8-in. diam.	AWWA primer, AWWA enamel, and felt wrapper for exterior; three coats Class (5) for lining.	Two coats Class (3) exterior, glass and/or felt; three coats Class (5) for lining.
Effluent lines under 120 F	Same as water lines.	Two coats Class (3) coating and lining, glass and/or felt.
Gas lines, natural gas	AWWA primer, AWWA enamel, felt wrapper on coating.	Two coats Class (3) glass and/or felt for exterior.
Gas lines, scrubbed coke oven gas	Same as water lines.	Two coats Class (3) glass and/or felt for exterior; two coats Class (4) for lining.
Sewer lines, Steel	Same as effluent lines.	Same as effluent lines.
Concrete	Two coats Class (2) for lining.	.....
Tanks, Steel	AWWA primer, AWWA enamel, felt.	Two coats Class (3), glass and/or felt.
Above ground:		
All pipe lines, exterior	Two coats Class (3), one top coat Class (4).	Two coats Class (2), one top coat Class (4).
Tanks, Mild corrosion conditions	Two coats Class (1).	.....
Severe corrosion conditions	Two coats Class (3), one top coat Class (4).	Two coats Class (2), one top coat Class (4).
Maintained to 200 F.	¼-in. Cork-filled coal tar compound; top coat Class (4).	.....
Structural steel	Two coats Class (2), one coat Class (4).	One coat Class (2), one coat Class (4).
Piling	Two coats Class (3), one top coat Class (4) above grade or above water line.	AWWA primer, AWWA enamel top coat Class (4) above grade or water line.
Railroad ties	Coal tar tie sealing compound; cover aggregate.	.....
High temperature surfaces (500-1000 F)	One coat metal pigmented oil-base paint.	.....

diameter pipe above ground are usually protected by primer and at least two coats of Class (4) emulsion and the interior receives the special tasteless and odorless coating mentioned above.

Based on a background of accumulated knowledge of the fundamental properties of coal tar coatings, the years of experience under various kinds of service conditions, including particularly severe corrosive service environments, and specific experience and information gained in steel plants as described above, Table II is offered as a general guide for steel plant preventive maintenance.

SUMMARY

The information here presented should aid in selecting the most appropriate type of coal tar coating for the surface to be protected, the corrosive environment to be encountered, the accessibility of the structure needing insulation, and the anticipated service life of the protective coating system selected.

Manufacturers of the coatings should be consulted if any unusual conditions or circumstances prevail. Complete records of surface preparation, application conditions, selection and coverage of applied coatings, and severity of exposure should be kept for future reference.

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DISCUSSION

PRESENTED BY

DR. JOSEPH BIGOS, Director of Research, Steel Structures Painting Council, Pittsburgh, Pa.

E. J. GARDNER, Assistant to Vice President Operations, Inland Steel Co., Chicago, Ill.

W. F. FAIR, JR., Coatings Consultant, Tar Products Div., Technical Dept., Koppers Co., Inc., Pittsburgh, Pa.

H. J. CIBULA, Sales Representative, Tar Products Div., Sales Dept., Koppers Co., Inc., Pittsburgh, Pa.

Dr. Joseph Bigos: At the outset, I wish to congratulate Dr. Fair and Mr. Cibula for an excellent presentation of the problems connected with the use of coal tar coatings in steel plants, as well as a development of basic principles governing the proper use of protective coatings in steel plants. Such comments as I have to make are to be considered in a minor category and are intended to bring out some details not sufficiently covered or else to correct minor possible misunderstandings.

The writer is in complete agreement with the suitable use of coal tar coatings—both hot applied and cold applied—in steel plants and auxiliary surroundings. In many cases, they will provide protection which cannot be obtained from other types of organic coatings—notably underground and for water immersion.

The subject of surface preparation is given its due importance. I do not agree with the authors in their statement that "the surface should be completely free of . . . mill scale . . . rust . . ." I do wish to emphasize the fact that mill scale can be an extremely undesirable substrate for paint. Mill scale is cathodic to iron and steel and therefore under proper conditions electrochemical corrosion occurs with a surprisingly high voltage developed between the mill scale and the bare areas. As a result of the galvanic couple that is formed, accelerated corrosion and pitting can occur in breaks in the mill scale and complete perforation of the metal may occur in a surprisingly short time. However, this danger is great only when exposed to strong electrolytes such as sea water or brine. Under normal conditions of exposure, mill scale can be a good substrate for paint. The millions of square feet of structural steel which have been painted over mill scale with satisfactory and economical results attest to this fact. As the severity of the exposure increases, then economics change, and it becomes increasingly more important to resort to better and better methods of surface preparation. Weathering, which is mentioned in the paper, is a good method of helping remove mill scale provided the surface is sandblasted afterwards. When mill scale must be removed for cases such as immersion in strong electrolytes and blast cleaning or pickling is impossible, then weathering is the only alternative and should be used.

The comment was made that "blasting by sand or by shot is probably the best method for removing mill scale and other contaminants." I believe this may be subject to misinterpretation. Shot blasting is not necessarily a good method for removing mill scale; what the authors undoubtedly are referring to is the use of crushed cast iron shot or grit which is a good method for removing mill scale and rust. Round shot has a tendency to pack rust and contaminants and mill scale into the surface. Also, smooth, round shot does not provide a good anchor because of the smooth indentations which result. In connection with the use of rust inhibi-

tive washes after sandblasting, the use of wash primer for this purpose also should be considered since it is one of the best methods. Also, it can provide protection for much greater periods of time than the other materials normally used.

The problems associated with hydrogen embrittlement and pickling—particularly when electropickling is used—are difficult to overcome by heating alone. Normally, heating to remove hydrogen after pickling is not done. It does remove absorbed hydrogen to a degree, but it fails to remove the absorbed, nascent hydrogen which collects in cracks and minute interstices between crystals. When steel which has been pickled is allowed to stand for several days, the hydrogen which will come out will be removed.

In regard to flame cleaning, I believe the authors mean to convey the impression that application of the coatings should follow as soon as practical after passage of the flames and wire brushing, but before the steel has had a chance to cool to room temperature. If this practice is not followed, most of the benefits of flame cleaning are believed to be lost.

The comments concerning the use of wash primer under coal tar coatings should be clarified to show beyond any question of doubt that the wash primer is not used under the hot applied enamel, at least not without the application of the customary solution type of primer over the wash primer.

I do question the meaning of water absorption charts such as illustrated by Figures 9, 10, and 11. Since Figure 11 shows that a loss in weight is possible, then the column Grams of Water Absorbed per Unit Area During Immersion does not mean much unless there is sufficient scientific data to prove beyond a question of a doubt that nothing has been given up while the water has been absorbed. I would much prefer to rest the case for the use of coal tar on service data or test data such as that given in Bureau of Standards Circular No. C450 which clearly shows the excellent results obtained from the use of coal tar.

In connection with the use of cold applied coal tar coatings, I should like to call attention to the remarks under surface preparation and point out that these remarks unfortunately are slighted by the sales representatives of coal tar coatings who intimate that excellent results or almost just as good results are obtained over poorly cleaned surfaces or over wire brushed surfaces. Recent test results show a surprising difference in performance of cold applied coal tar coatings over wire brushed surfaces in contrast to sandblasted surfaces in severe exposures.

I believe that the authors have neglected to tell exactly what kind of primer is recommended prior to application of the emulsified type of coal tar coating.

The statement is made that "the residual films left by evaporation of the solvents from these coatings are all chemically inert and resistant to . . . sunlight . . ." I do not concur that the coal tar coatings are all chemically inert by far. To the contrary, they are dissolved by many solvents and attacked by many chemicals. Also, the poor resistance of coal tar coatings—other than the emulsion type—to sunlight is well known. This failure on exposure to sunlight is mentioned later in the paper.

The recommendations for steel work followed general good practice. There are two points which I should like to mention since I consider them to be weaknesses in the use of coal tar coatings. The first is the tendency for coal tar coatings to fail over sharp corners and edges and irregular surfaces such as ladders and lattice work. The other is the unfortunate tendency for coal tar filled coatings to be undercut by rust in very corrosive surroundings. These are problems which require further work. Also, one manufacturer's coatings are frequently not compatible with another, requiring the entire system to be procured from one manufacturer.

In spite of these drawbacks, coal tar coatings are certainly among the best for the protection of steel plants.

E. J. Gardner: The information furnished in this paper is very valuable to anyone operating a coke plant.

I realize that Dr. Fair could not cover all the problems that we have in a steel plant, nor maybe all the problems in a coke plant, which has more corrosion problems than any other department of a steel plant.

Dr. Fair, no doubt has some information on the tests made in regard to:

1. The control of tar acids in raw tar—so as not to affect steel.
2. How is this type of paint affected by phenol vapors given off of cooling towers and coke quenching towers?
3. Is this tar base paint a good coating for a coke quenching car?

Dr. W. F. Fair, Jr.: On the question, what about the tar acids in the tar base coating, the base material is above the boiling range of the common and more reactive acids in tar. I am not saying there are none there. We do not know. There are a lot of things in the bituminous hydro-carbons that have never been identified, but the common things such as phenol are taken out long before you get to making these coatings.

E. J. Gardner: What effect do the phenol vapors in the cooling towers have on this paint?

Dr. W. F. Fair, Jr.: You mean vapors that blow across the surfaces painted with it?

E. J. Gardner: Yes.

Dr. W. F. Fair, Jr.: From the quenching station of one of our own plants, we have such an exposure which is very severe. One of the things that Dr. Bigos referred to—and which I will come back to—when he spoke of the sandblasted versus wire brushed surfaces, refers to tests in just that area. Several systems were tried there. We have about twenty of them on a big tower and also on some oxide box tops, with different coal tar solvent types for the first coat, and then the emulsion for the top coat. There has been no bad effect whatsoever in something over two years. The systems look as though they will last indefinitely on the sandblasted surfaces.

H. J. Cibula: Because of the high temperatures involved with the quencher cars, and because the coal tars age with loss of oils, we normally do not use any of our coal tar materials on quencher cars.

E. J. Gardner: Have you any recommendation as to what we could use?

H. J. Cibula: I do not believe there are any coatings that will last. After all, if the steel car is eaten up in a matter of 12 to 18 months, you have to replace it. One cannot throw red hot coke on a coating at 1800 or 2000 F and expect it to be unaffected. That is the part that gives you the most difficulty because the use of your phenol tower waste ammonia liquor water, which you cannot dump in the lake or the river, is highly contaminated, high in chlorides, and it just chews off practically all of the coatings that have been used to date.

I have not found anything, except one or two of them which sometimes show signs of doing some good, but I do not know whether the economics are justified or not.

Dr. W. F. Fair, Jr.: I will go on to comment on Dr. Bigos' criticisms then. First, I should say we stand corrected. We should have used the term "grit blast" rather than what we did.

In connection with mill scale, we were concerned here only with severe environments which require good surface preparation.

We concur in Dr. Bigos' statements on flame cleaning. We have only recommended wash primer as part of the surface preparation prior to application of cold applied coal tar coatings.

One of Dr. Bigos' points was about the validity of those water absorption tests. As he pointed out—and correctly so—there is a possibility that leaching might occur from the material into the water which might make the apparent gain in weight very small. In other words, if you have a square foot of immersed surface and after a year it has only gained one gram, it could be that you lose four grams to the water and actually gained five grams or a net gain of one, and it makes it look like a low water absorption. Naturally we thought of that some time ago.

We were limited in this particular paper. I did not want to write volumes. However, the information that would settle this question is available. About five or seven years ago, the American Society for Testing Materials had a symposium on durability testing of bituminous materials. At that time I and two colleagues from Mellon Institute presented a paper giving the amounts of material that were dissolved, and we actually weighed and recovered the materials leached from coal tar pitches.

This work was really prompted by research at the Bureau of Standards by Streeter and Snoke,[11] who, working with asphalts, found out that asphalts subjected to ultra-violet and water immersion developed water soluble acidic materials on the surface. We thought we had better find out what coal tar would do under such conditions. We took tars and pitches of different kinds, filled and unfilled, and we had a wide variety—I think over 200 different ones—and we put coatings on different panels. Each panel was exposed to ultra-violet light nine hours every night and four hours the next day immersed in distilled water.

At the end of each five-week period, the water was titrated to neutrality, the water evaporated to dryness and the residues weighed. This went on for eleven five-week periods.

This paper appeared in the ASTM Proceedings, for June, 1949. It also was printed with the other papers presented at this symposium in ASTM Special Technical Bulletin No. 94, pp 109-121.

Reference to Table II, p 112 of this Bulletin shows that the gain in softening point was quite small, a lot smaller than we had expected during this rather rough treatment for 55 weeks.

Table III and Figure 1, page 113 of this bulletin show the amounts of sodium hydroxide needed to neutralize the water. The total amount, adding up the eleven five-week periods, was only a few cc of a weak solution of sodium hydroxide solution.

Table IV and Figure 2, page 114 of this bulletin show the residues we obtained in 55 weeks—too small numerically to be significant in view of the amounts we found by the water absorption tests. So I think Dr. Bigos' point, although well made, we have answered.

One other thing, Dr. Bigos mentioned the surprising difference between sand blasted and wire brushed surfaces, with coal tar coatings. I would like to expand on that a little bit. He and I are both interested in this particular project. It is an experimental one in one of our own plants. A great many of the systems put on there were at his suggestion and that of other non-bituminous paint chemists. We sandblasted off paints that were perfectly good—they had a bad time blasting the coal tar off of the oxide box lids. Finally, after using tons of sand they had to resort to chipping and then sandblasting and then over the sandblasted surfaces we put some 28 different systems, many of which had non-bituminous primers of the type I discussed a little while ago.

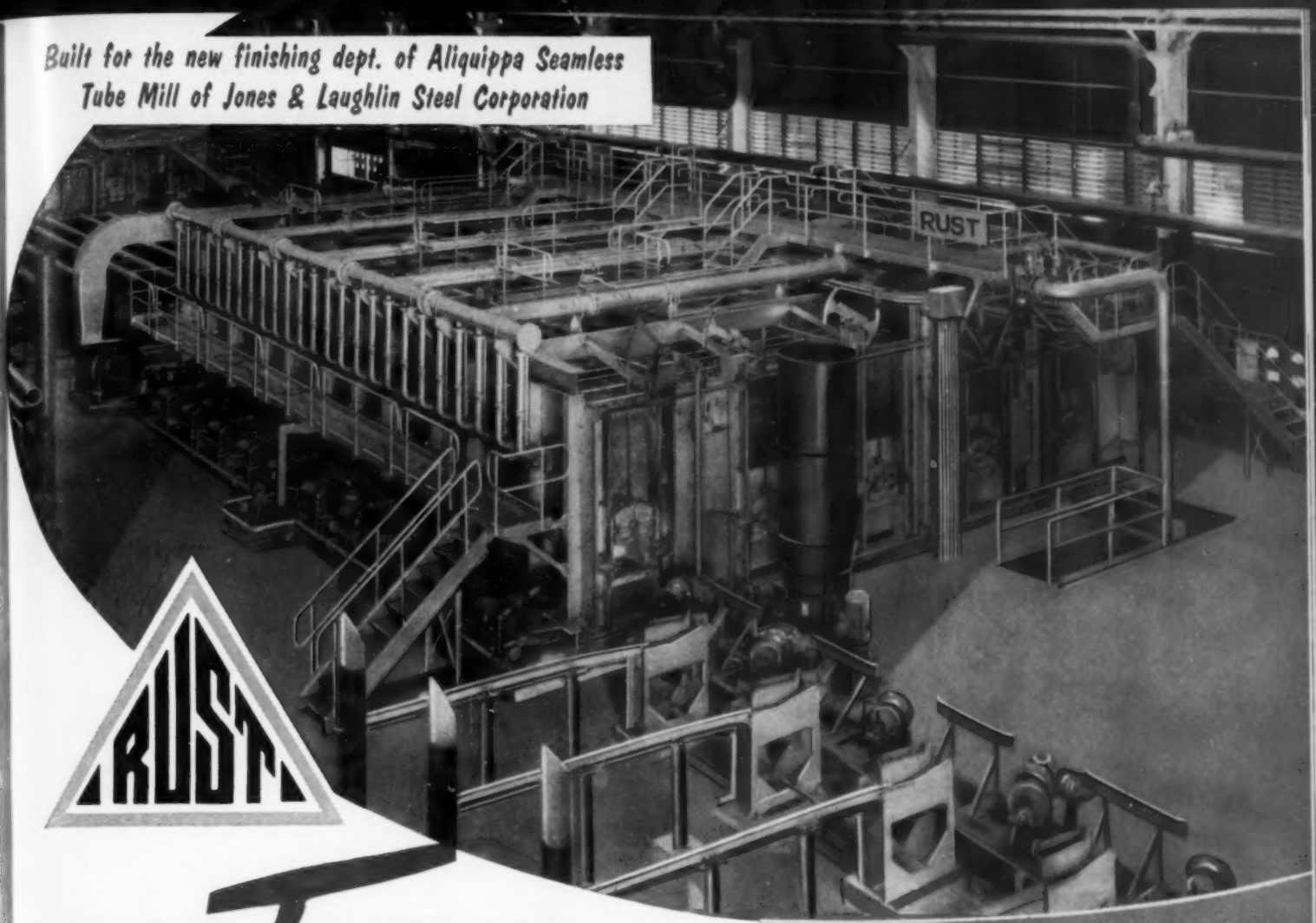
On an adjacent area we had wire brushed surfaces with the same systems put on. The top coat in every case was the coal tar emulsion. The first coat varied, being bituminous or non-bituminous. As for results, no matter what the system, none of them stuck well in this very bad environment to the wire brushed surfaces, and they are all doing extremely well after some two or two and a half years on the sandblasted surfaces. I wanted to enlarge upon what Dr. Bigos said there because I think it gives somewhat the wrong idea about coal tar systems.

As far as what coal tar sales representatives say about sandblasting or not sandblasting, I have no control. I can only say we advise all our people to recommend good surface preparation and with us that means sandblasting or grit blasting.

The emulsified tar coating may be applied over wash primer, or over compatible non-bituminous primers, or over any of the solvent cut-back tar base primers or coatings.

In the matter of undercutting, we have found that this is primarily due to severe environments, and is usually associated with poor surface preparation and faulty application. We have under exposure in different parts of the country scribed and unscribed test panels protected with bituminous, with non-bituminous, and with combination coating systems. Little undercutting is being observed, in two to four years, and no significant differences have yet been established. It is intended to publish soon, an interim report on the results of this comprehensive atmospheric exposure testing program.

Built for the new finishing dept. of Aliquippa Seamless Tube Mill of Jones & Laughlin Steel Corporation



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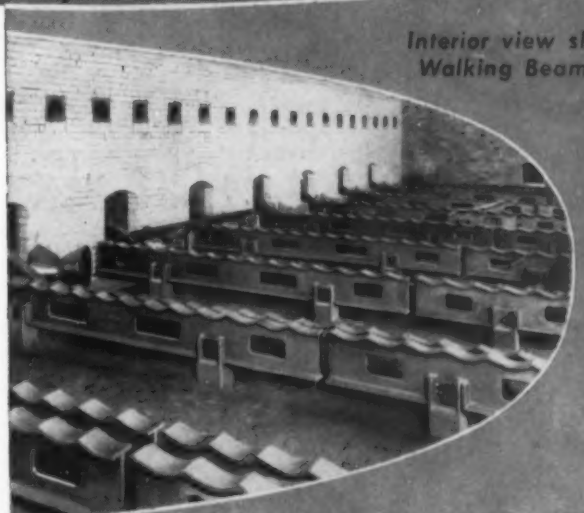

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END OF CAMPAIGN	TOTAL HEATS	HOURS LOST ON REPAIRS	REFRACTORY	REASON FOR LOST TIME
5/10/52	86	12:10	No CORHART 104	Two large patches to walls and gunning time.
8/28/52	93	10:20	No CORHART 104	Two large patches to walls and gunning time.
10/9/52	118	6:50	Some CORHART 104	Brick or gunning repairs.
11/7/52	103	12:05	No CORHART 104	Two large patches.
1/4/53	90	4:10	No CORHART 104	One large patch and gunning time.
2/5/53	105	4:35	No CORHART 104	One large patch and gunning time.
3/13/53	126	4:25	CORHART 104 in *"Hot Spots"*	Patching top of wall and gunning wall.
4/16/53	136	11:40	CORHART 104 in *"Hot Spots"*	Brick repair to top of walls only.
5/26/53	127	8:55	CORHART 104 in *"Hot Spots"*	Brick repair to top of walls only.
7/1/53	129	5:05	CORHART 104 in *"Hot Spots"*	Brick repair to top of walls only.
8/5/53	117	15:25	No CORHART 104	Three large patches and wall gunning.
9/23/53	119	5:10	Some CORHART 104	Brick and wall gunning.
11/7/53	137	10:05	CORHART 104 in *"Hot Spots"*	Patching top of walls.
2/17/54	105	7:10	No CORHART 104	One large and one small patch.
4/11/54	151	10:20	CORHART 104 in *"Hot Spots"*	Patching top of walls.
5/31/54	146	12:35	CORHART 104 in *"Hot Spots"*	Three small patches to top of wall.
9/4/54	135	22:30	CORHART 104 in *"Hot Spots"*	Patching top of walls.
10/8/54	143	13:25	CORHART 104 in *"Hot Spots"*	Patching top of walls.
11/7/54	135	4:05	CORHART 104 in *"Hot Spots"*	Patching top of walls.
1/27/55	118	6:50	CORHART 104 in *"Hot Spots"*	Patching top of walls.
3/7/55	129	4:25	CORHART 104 in *"Hot Spots"*	Patching top of walls.
4/15/55	130	12:05	CORHART 104 in *"Hot Spots"*	Patching top of walls.
5/18/55	107	8:40	CORHART 104 in *"Hot Spots"*	Patching top of walls.
6/25/55	122	7:35	CORHART 104 in *"Hot Spots"*	Patching top of walls.
8/19/55	131	9:50	CORHART 104 in *"Hot Spots"*	Patching top of walls.
9/30/55	136	8:10	CORHART 104 in *"Hot Spots"*	Patching top of walls.
11/11/55	138	4:20	CORHART 104 in *"Hot Spots"*	Patching top of walls.
1/13/56	171	14:25	CORHART 104 in *"Hot Spots"*	Patching top of walls.

Average heats per campaign with little or no CORHART 104.....100
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CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, March 26, 1956 — Cocktail Hour and Dinner 6:30 P.M., Meeting 8:00 P.M.

"Recent Improvements and Applications on Gear Type Couplings," by F. H. Paddon, Manager of Engineering Sales, American Flexible Coupling Co., Erie, Pa.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, March 13, 1956 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Rectifiers for the Steel Industry," by R. J. Moran, Steel Mill Engineering and A. Schmidt, Jr., Power Conversion Engineering, General Electric Co., Schenectady, N. Y.

Hotel Sheraton, 715 Delaware Avenue, Buffalo, N. Y.

CHICAGO SECTION

Tuesday, March 6, 1956 — Dinner 6:30 P.M., Meeting 7:45 P.M.

"Symposium"

"Metallurgical Analysis as a Tool for Maintenance and Operating Departments," by R. H. Davis, Maintenance Metallurgist, United States Steel Corp., Gary, Ind., A. G. Forrest, Chief Metallurgist, Republic Steel Corp., Chicago, Ill., and M. E. Olson, Superintendent Mechanical Maintenance, Youngstown Sheet and Tube Co., East Chicago, Ind.

Phil Smidt's Restaurant, 1205 N. Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, March 20, 1956 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"The Meaning of Atomic Energy to Industry," by Dr. R. P. Petersen, Director, Nuclear Research, Republic Steel Corp., Cleveland, Ohio.

University Club, 3813 Euclid Avenue, Cleveland, Ohio.

DETROIT SECTION

Tuesday, March 13, 1956

"Great Lakes Steel Corp. Night."

I. Oxygen Use in the Blast Furnace
II. World's Largest Blast Furnace
III. New Material Handling Facilities

Time, location and speakers to be announced later.

LOS ANGELES SECTION

Monday, March 12, 1956 — Dinner 7:00 P.M., Meeting 8:00 P.M.

"Review of Start Up of First Sendzimir Mill in the Far West," by Louis Zdanowicz, Chief Engineer, Calstrip Steel Corp., Los Angeles, Calif.

Rio Hondo Country Club, 10627 South Old River School Road, Downey, Calif.

PHILADELPHIA SECTION

Saturday, March 3, 1956 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Expansion Program, Saucon Division, Bethlehem Steel Co.," by J. A. Bell, Chief Engineer, R. W. Couch, Superintendent, Saucon Mills and Shipping Yard, and R. L. Willis, Superintendent of Construction, Bethlehem Steel Co., Bethlehem, Pa.

Engineers' Club, 1317 Spruce St., Philadelphia, Pa.

Wednesday, March 7, 1956

"The Effect of a Well Balanced Safety Program on the Community," by John J. Appleyard, Director of Public Relations, United States Steel Corp., Philadelphia, Pa.

"Values of a Well Balanced Safety Program," by F. R. Barnako, Manager of Compensation and Safety, Bethlehem Steel Co., Bethlehem, Pa.

This meeting is to be held in connection with the 22nd Annual Regional Safety Conference, 2:30 P.M., Broadwood Hotel, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, March 12, 1956 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Brains and Muscles of an Ore Bridge," by H. A. Zollinger, General Mill Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"Raw Material Inventory of Coal," by William S. Massa, Chief of Photogrammetry, Tennessee Valley Authority, Chattanooga, Tenn.

"Raw Material Inventory Through Photogrammetry," by Robert A. Cummings, Jr., Robert A. Cummings, Jr. and Associates, Pittsburgh, Pa.

"Aerial Mapping Surveys" — Three Dimensional Color Sound Movie.

Alumni Room, University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Data not available.

SAN FRANCISCO SECTION

Tuesday, March 13, 1956 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Kaiser Steel Corp. Night"

"The Kaiser Steel Corp. Air Control Program," by Jack H. Smith, Technical Engineer, Air Control and Research Dept., Kaiser Steel Corp., Fontana, Calif.

Shattuck Hotel, Durant and Shattuck Streets, Berkeley, Calif.

YOUNGSTOWN SECTION

Monday, March 26, 1956 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Application of Eddycurrent Adjustable Speed Drives in the Steel Industry," by Tom Skarakis, Dynamic Div., Eaton Manufacturing Co., Cleveland, Ohio.

Mahoning Country Club, Girard, Ohio.

Performance of Rectangular Bell Type Annealing Furnaces

By R. R. LAPELLE
Advisory Engineer
Industrial Heating Div.
Westinghouse Electric Corp.

▲ TWO rectangular bell furnaces built for long cycle and spheroidized annealing of high carbon and tool steel bars have now been in continuous operation for over two years. Supplied by Westinghouse Electric Corporation, they are believed to be the first in which alloy tool steels are being spheroidized on a long cycle directly in a brick lined chamber without any muffle and without removing mill oxide from the bars before annealing. It is also probably the first in which atmospheric control is provided of the recirculating type utilizing Monogas as a control atmosphere to enable carbon restoration to be carried out on the decarburized surfaces.

The furnace fuel is natural gas and is fired by radiant tubes located both in the stationary base and in the movable bell portion. The material is loaded into the furnace on racks; the work being handled consists of square, rectangular, and round bars of tool steel. A charge may weigh from 10,000 to 30,000 lb, with the latter figure representing a conventional run.

The cycle employed consists of heating the entire load to a temperature of 1300 F at as fast a rate as possible, usually from 3 to 4 hours. It is then soaked at 1300 F for approximately 8 hours.

During this period, raw natural gas is added to the Monogas makeup gas in order to provide a reducing agent for the reduction of the mill scale which is on the bars when they go to the furnace. During this portion of the cycle, the purpose of the operation is primarily to purge out all of the water that is produced due to air in the furnace brick work, oxide on the surface of the bars, and entrapped air from opening the furnace for charging. The dewpoint is sampled every hour by means of a dewpoint instrument and soak is continued until the dewpoint drops to at least 15 F above zero.

At the conclusion of the purge, temperature is increased at the rate of 30 degrees per hr to a soaking temperature of 1550 F, depending upon the alloy being treated, and the material is soaked at this temperature for six hours. During the heating and soaking cycle, the dewpoint inside the chamber and the specific gravity of the gas is watched continuously to make sure that the gas in contact with the steel has the right dewpoint and the right carbon potential for the particular steel being treated.

Following the soak period, the material is cooled at the rate of 30 degrees an hour to 1200 F—held for 15 minutes for equalization throughout the load and is then moved from the furnace and allowed to cool in air.

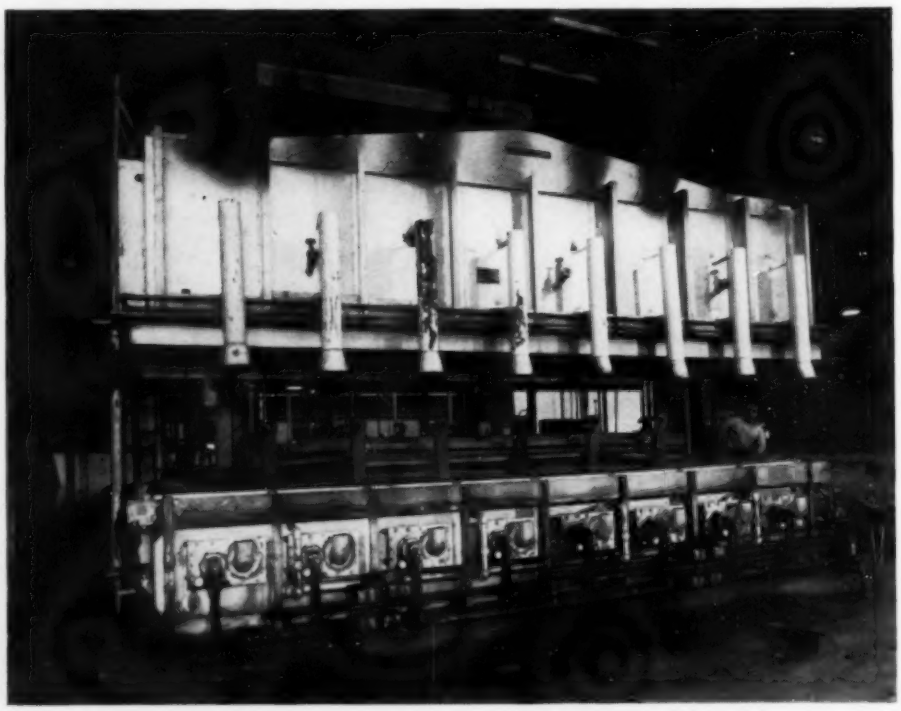
The results obtained based upon high speed steel indicate that the carbon content within the outer layers of the bar after annealing can be held within 0.05 per cent carbon for the first two 0.005 in. cuts made in determining carbon content.

This result occurs on material which went into the furnace originally with 0.010 to 0.015 in. nearly total decarburization which had been acquired in the mill furnaces previous to annealing.

The hardness values obtained from the furnaces have been uniformly good with most of the materials being annealed from 228 to 241 Brinell. This value is constant throughout the entire 30,000-lb load; however, the actual level depends upon the alloy being handled.

This uniformity, both of surface condition and of hardness, makes it possible to cut down considerably on the inspection usually necessary with annealed loads and, of course, pickling has been entirely eliminated.

Figure 1 — One of two rectangular bell furnaces for long cycle and spheroidized annealing of high carbon and tool steel bars which have been in operation over two years. In them, alloy steel bars are spheroidized on a long cycle without any muffle and without removing mill oxide prior to annealing.



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Here's a man with experience, where experience counts, on-the-job experience in heavy industrial lubrication.

He's a man who is typical of Atlantic service. Selected to represent Atlantic because he *is* a specialist. And he's backed by other Atlantic specialists in lubrication research, production, quality control and transportation.

Atlantic has served customers successfully for 85 years because Atlantic has developed the products necessary to do the lubrication job right at the lowest cost to the lubricant consumer.

Why not benefit by this combination of correct lubricants and technical service? Simply write, wire or phone the Atlantic office nearest you for full information on Atlantic lubricants. The Atlantic Refining Company, Dept. V-2, 260 South Broad Street, Philadelphia 1, Pa.

ATLANTIC

Pumping Progress Report

FOR MECHANICAL ENGINEERS

An advertisement prepared by the Aldrich Pump Co., Member of Hydraulic Institute, U.S.A.

PUMP INSPECTION, MAINTENANCE AND REPAIR are jobs too frequently ignored in the design of production pumps. This has been verified by a survey of more than 15,000 pump installations. Speed and economy of maintenance was frequently quoted as a major factor in pump selection.

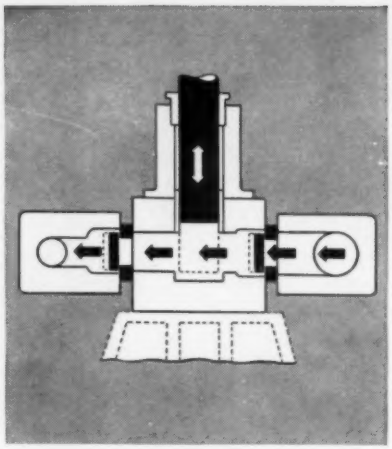
SECTIONALIZED FLUID-ENDS offer one of the best ways to guarantee both speed and economy in pump maintenance. As originated by ALDRICH Pump Co. Engineers, the Sectionalized Fluid-End comprises four main assemblies — the working barrel, suction manifold, discharge manifold and stuffing box.

SPEED IN MAINTENANCE is assured because of ease of accessibility of all wearing parts. Manifolds can be slid back on studs and valves removed as complete units. Split collar and flange connection of plunger to yoke permits easy removal of plunger.

ECONOMY OF MAINTENANCE results from speed in maintenance. Perhaps even more important is the simple fact that it is cheaper to replace a single section than a complete fluid-end. Another important economy is parts interchangeability. Among 3-, 5-, 7- and 9-plunger units of any series, wearing parts are interchangeable. Where a combination of multiplex pumps is required, this reduces spare parts stocks.

THE ALDRICH PUMP COMPANY is the originator of the DIRECT FLOW principle — a design innovation that utilizes the sectionalized fluid-end principle. Aldrich Engineers have become known as the people to take your tough pumping problems to. We have never turned down a challenge.

FURTHER INFORMATION can be had direct from the company. Tell us your problem and we'll send you Data Sheets describing the size pump we recommend to solve your problem. Address your request to: The Aldrich Pump Company, 21 Pine Street, Allentown, Pa.



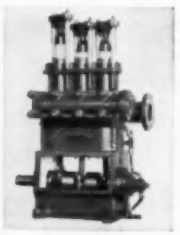
Aldrich Direct Flow Fluid-End Design

...for your tough pumping problems specify ALDRICH

The Direct Flow principle, an Aldrich design innovation, is a major forward step toward the solution of tough pumping problems of all kinds. Not only does it eliminate two right-angle turns in the fluid-end, but in addition makes possible complete Fluid-End Sectionalization. This is another Aldrich design innovation which permits economies of maintenance and repair offered by no other type pump.

CHECK THESE ADVANTAGES OF SECTIONALIZED FLUID-ENDS:

Less expensive parts replacement
Ease of inspection and maintenance
Interchangeable wearing parts
No special equipment for valve removal
Easily accessible stuffing boxes



Write today for Data Sheets describing the Direct Flow Pump Series.

THE ALDRICH PUMP COMPANY

Originators of the Direct Flow Pump
21 PINE STREET
ALLENTOWN, PA.
Representatives in principal cities

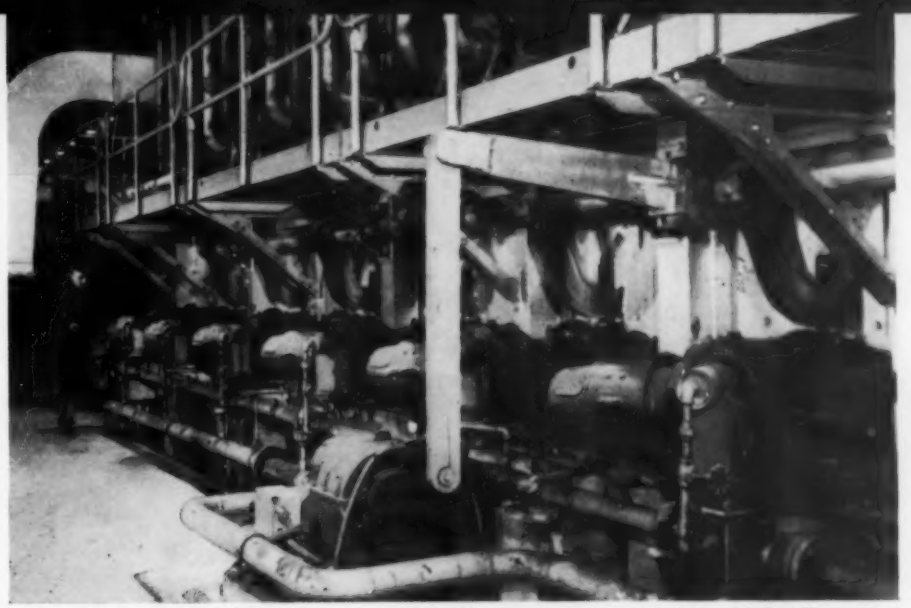


Figure 1 — The motorcylinder in the foreground operates the kick-off arms to remove tubes from furnace inlet tables onto the furnace bed. "Floating-shaft" gearmotors for table rolls are in background.

Gearmotors Guide Pipe Through Heat Treating Line

By J. W. BRINKS
Steel Mill Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

▲ GEARMOTORS play an important part in carrying seamless tubes through J&L's new heat treating facility installed at Aliquippa. "Floating-shaft" gearmotors and motorcylinders used in this installation have unique application and design features.

Cold seamless tubes, with or without upset ends, are conveyed through one or both of two normalizing and heat treating furnaces, quench unit, cooling beds, and straightener, to a finishing department where the tubes are inspected and threaded.

Each of the conveying table rolls is driven by a gearmotor of the "floating-shaft" type which is specially designed for direct mounting on the roll shaft extension and is anchored to the table with torque rods to prevent turning. The units are entirely free to ride with the roll in operation. Each gearmotor is of the horizontal right angle type and is rated at 2-hp, 60-rpm, with Class III, 29:1 ratio worm gearing. The totally enclosed d-c motors are rated 2-hp, 1750-rpm, at 230-volts.

Another unique design feature of these floating gearmotors results from the need of water-cooling the shaft of the table rolls in the furnace. As shown in Figure 1, the cooling water is introduced into the low speed shaft, flows inside a pipe, and returns back over the outside of the pipe and into the drain. This necessitates a tight seal between the gearmotor shaft and the roll shaft.

The table motors are supplied from adjustable voltage generators for speed control through the quench unit and for controlling speed into the furnace.

This installation marks the debut of the motorcylinder in the steel industry. The motorcylinder, originally developed for the lumber industry, is a geared drive assembly with crank arm on the low speed shaft to produce reciprocating motion. An a-c squirrel cage induction motor equipped with a motor-mounted brake drives the unit. Cam-operated limit switches provide automatic stopping at selected points of the cycle. Eight such units are used for tube kick-offs on this installation.

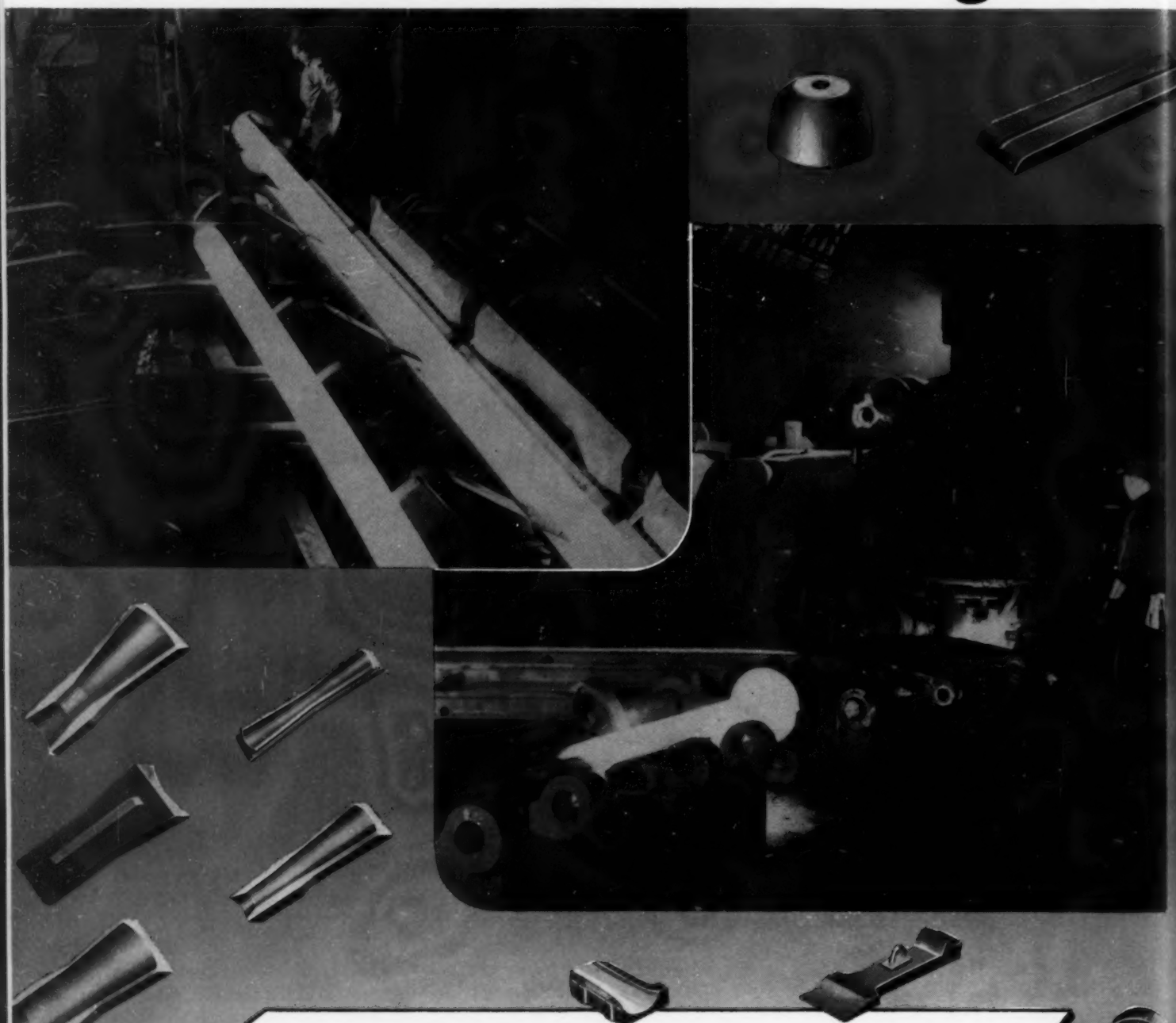
Standard motorcylinder units are available in horsepower ratings of 1 to 20 hp, crank stroke lengths from 8 to 24 in., and stroke times of ½ to 1½ sec. These units are especially adaptable to repetitive uniform stroke applications as replacements for air or hydraulic cylinders. Thrust capacity of these units varies from 210 lb with 1 hp motor at high speed long stroke, to 17,900 lb at low speed short stroke with larger motor. Higher thrusts are available with "offset" type units.

LUKENS INSTALLS NEW ARMOR PLATE LEVELLER

By A. J. WINCHESTER
Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

▲ AN armor plate roller leveller with ignitron rectifier power supply was placed in operation in July, 1955 at the Lukens Steel Company. This installation is another example which demonstrates the increasing popularity of rectifier power supplies for industrial drives. The mill, which was built by Birdsboro Steel Foundry and Machine Company, is driven by a 600-hp, 375/765-rpm, 230-volt, mill type motor which is forced ventilated from an up-draft non-recirculating system with precipitron air cleaner. The adjustable voltage rectifier power supply is a six phase unit with six pumped type ignitron tubes. A magnetic amplifier voltage regulator is provided to maintain the rectifier bus voltage. Constant potential excitation for the motor and control is provided from a 10-kw, 250-volt selenium rectifier. With this combination of equipment, maintenance is minimized because the 600-hp mill motor is the only rotating component of the main drive equipment. The precise control which is possible with an individual rectifier power supply makes line contactors unnecessary. The mill is started and stopped by control of the rectifier voltage. A d-c electrically operated circuit breaker is provided for emergency trip. The mill motor is always accelerated to base speed by voltage control. The leveller may be run in either direction with reverse operation obtained by reversing the motor field. The operator has a master switch for selecting forward or reverse operation, and a control switch for selecting the top speed. The motor is stopped by dynamic braking.

TRANTINYL mill guides . . .



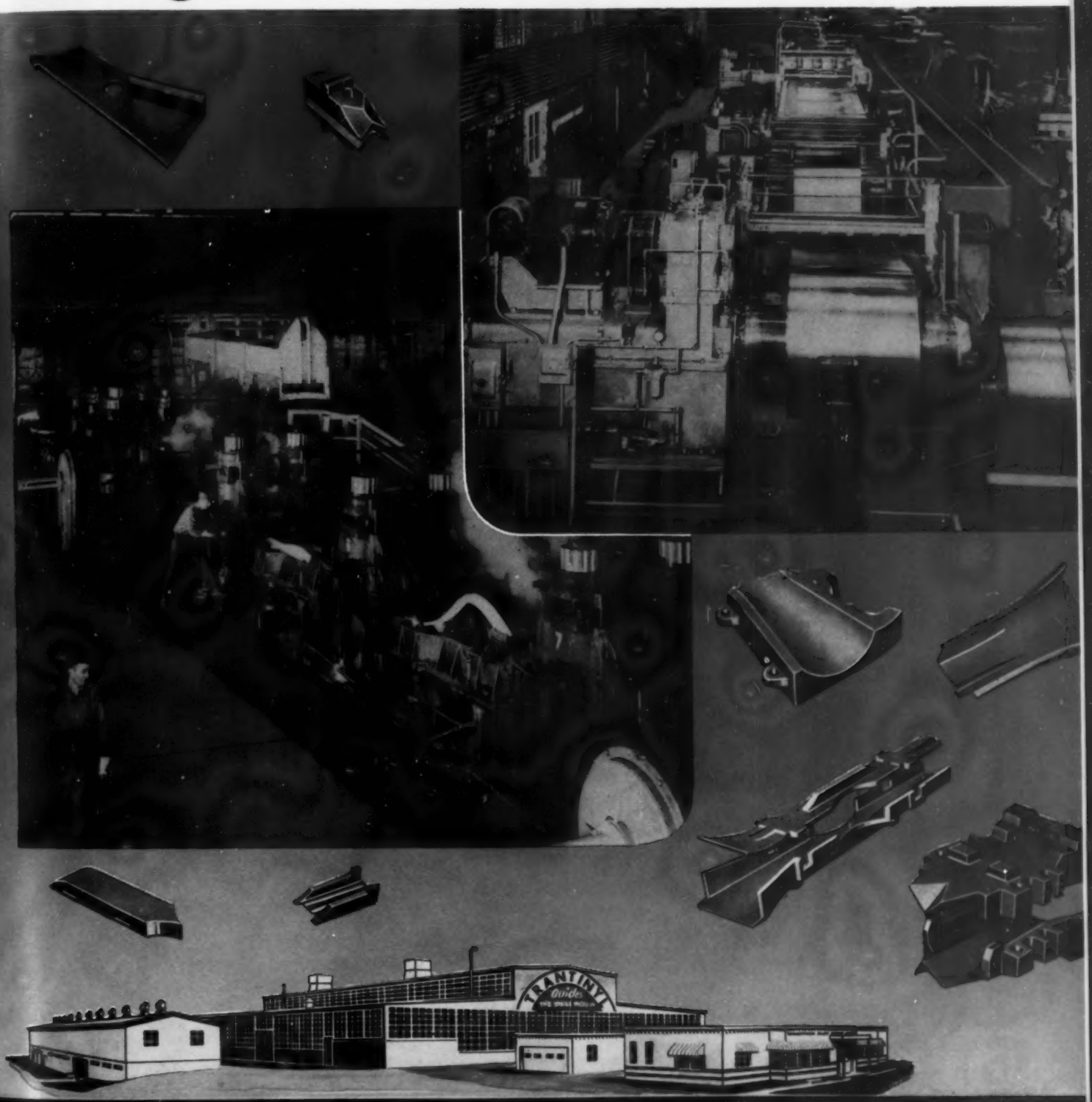
TRANTINYL Guides the Steel Industry

SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc.
ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc.
ROLLING MILLS: bar, hoop, strip, shape mill guides; and rollers
STRAIGHTENING MACHINE GUIDES · HEAT RESISTING CASTINGS

TRANTINYL
QUALITY DISTINCTION

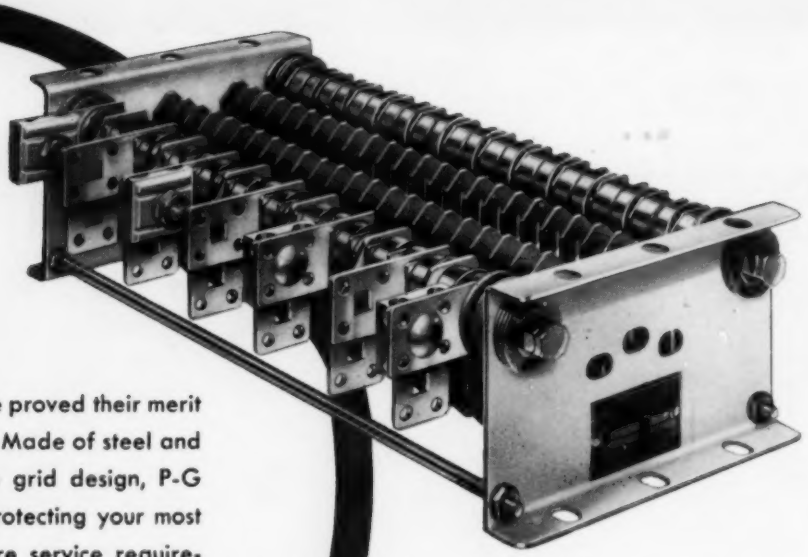
TRANTINYL Alloy Steels have no equal in tonnage rolled per set of guides"

· serving steel makers for over 20 YEARS



YOUNGSTOWN ALLOY CASTING CORPORATION • Youngstown, Ohio

Sole Licensee to cast "TRANTINYL" for the Midwest, West and South: WAUNAKEE ALLOY CASTING CORP., Waunakee, W

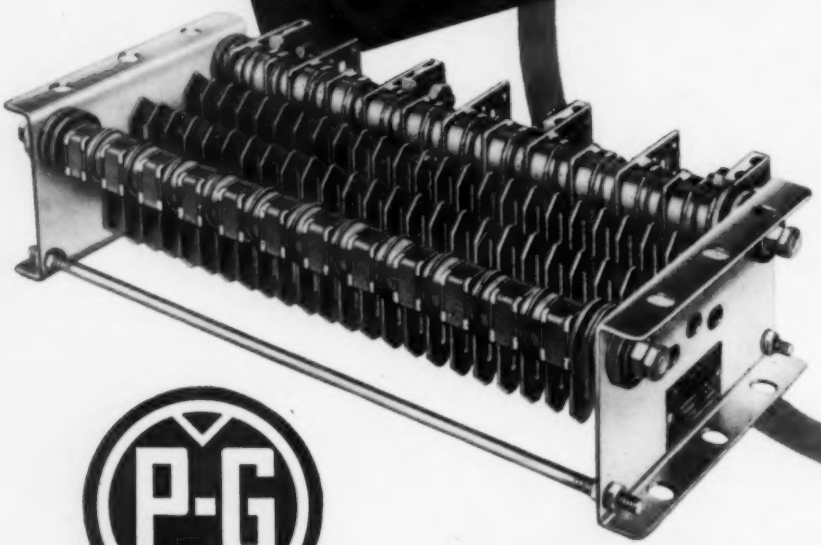


P-G STANDARD

Steel Grid Resistors

These rugged nonbreakable units have proved their merit in all kinds of service for many years. Made of steel and mica, plus P-G unique and exclusive grid design, P-G Standard Resistors are capable of protecting your most vital electrical equipment, even where service requirements are severe. Use of correct resistance value with ample capacity minimizes resistor trouble. ***Write for BULLETIN No. 500.***

P-G has BOTH!



P-G WELDED

Steel Grid Resistors

These units duplicate values of each P-G Standard Steel Grid Resistor. The only change is in adding welding links between resistance grids. Each welding link is made of the same alloy steel used for the grid. These links are heli-arc welded from grid to grid to create a continuous circuit without disruption to the normal path through contact spacers. Thus each P-G Welded Resistor has two paths available for carrying current. Naturally this offers double protection.

Write for BULLETIN No. 510.

P-G

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

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TORRINGTON *SPHERICAL ROLLER* BEARINGS

This bearing can take thrust, too!

Design is the secret. TORRINGTON Spherical Roller Bearings are made with an integral center flange on the inner race. This assures *positive radial stability and accurate positioning of rollers* wherever high radial load and heavy thrust are encountered under conditions of misalignment.

From crushers to cranes, power shovels to pulverizers, you get long, maintenance-free operation, better performance in your equipment, more value from your bearing dollar when you specify these rugged dependable bearings.

Prove to yourself that TORRINGTON design does make a difference. Next time specify TORRINGTON Spherical Roller Bearings. They're available with either straight or tapered bore, for shaft or adapter mounting.

THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

District offices and distributors in principal cities of United States and Canada

90th ANNIVERSARY 1866-1956

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller
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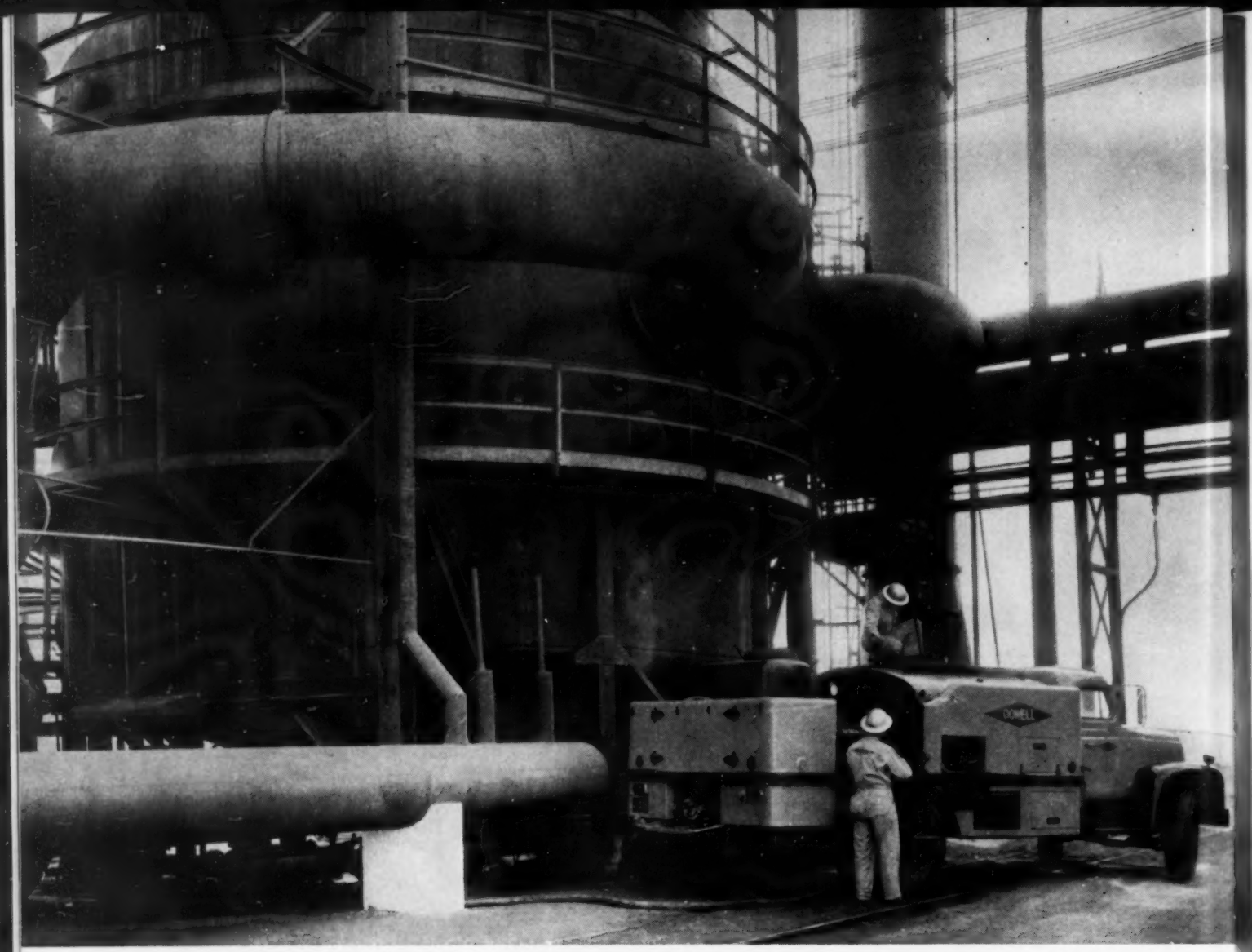


NO PRODUCTION SLOWDOWN DURING CLEANING

Without cutting gas output, DOWELL cleaned four precipitator sections chemically in only 15 hours—177 hours faster than mechanical cleaning

In today's steel plants, production schedules are more demanding than ever. Downtime may well spell the difference between profit and loss. That's one reason this operator was so pleased with Dowell chemical cleaning.

The operator had estimated that, using mechanical methods, it would take 192 hours to remove deposits from his four electrostatic precipitator sections. Dowell engineers, using chemical solvents, did the job in just 15 hours—saving 177 hours of valuable downtime. Inspection showed the sections to be free of scale and sludge. Moreover, no production was lost. Only a single section was taken out of service at any one time during the cleaning, allowing gas requirements to be met continuously.

With chemical cleaning, downtime is held to a minimum because solvents are introduced through regular connections. The liquid solvents used by Dowell go wherever water flows—cleaning all curves, angles and irregular surfaces.

Take advantage of Dowell's long experience in cleaning all kinds of industrial equipment. For full information call the nearest Dowell office—there are 165 in the United States and Canada. Or write to Dowell Incorporated, Tulsa 1, Oklahoma, Dept. B-29.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

January 2

▲ The AISI reports that the operating rate of the steel industry for the week of January 2 is scheduled at 96.4 per cent of capacity. This is based on the new 1956 capacity of 128,363,090 tons. This is equivalent to 2,373,000 tons compared with 2,309,000 tons one week ago and 1,960,000 one year ago. Index of production for the week is 147.7.

▲ According to the Dept. of the Interior, the nation's 1955 mineral output hit a new high of $15,800,000,000, an 11 per cent jump over the 1954 total of $14,100,000,000.

January 3

▲ Copper, lead and zinc are beginning the year in short supply as a result of the early December strike which is taking place in three U.S.-owned Chilean copper mines.

▲ Inland Steel Co. reached a record high in output in 1955 with an estimated 5,188,000 tons and an operating rate of 103.8 per cent. This compared with 1954's total of 4,522,464 ingot tons, an average of 96.2 per cent of capacity.

▲ Detroit Steel Corp. resumed operations of its No. 1 blast furnace at Portsmouth, Ohio after being closed since August 1953.

▲ The Justice Dept. announced a settlement with Cold Metal Process Co. on a patent infringement suit.

January 4

▲ Aluminum Co. of Canada raised the price of its primary aluminum to Canadian consumers to 22¼ cents per lb, an increase of 1¼ cents.

January 5

▲ The National Supply Co. formed a Mexican subsidiary with headquarters at Mexico City.

▲ Steel scrap prices in Pittsburgh made advances ranging from $1 to $3 per ton. No. 1 heavy melting scrap reached a level of $53 per ton, a record price for this scrap.

▲ Installment credit in November rose to $27,200,000,000, according to the Federal Reserve Board.

January 6

▲ According to The American Zinc Institute, U. S. smelter production for 1955 will exceed 1,025,000 tons while smelter shipments for the year will go well over 1,100,000 tons.

▲ President Eisenhower expects a balanced budget for the fiscal year beginning July 1, 1956.

▲ The Transport Workers Union averted a strike by accepting Pennsylvania Railroad's offer of an 18½¢ package wage increase.

▲ According to The International Nickel Co. of Canada, Ltd., free world nickel production in 1955 set another record with an estimated output of around 427,000,000 lb. This is an increase of around 40,000,000 lb over 1954's high of 387,000,000 lb and 87,000,000 lb over production in 1953. Output for 1956 is expected to continue to grow to an expected figure of around 442,000,000 lb.

▲ Basic prices for Canadian nickel remained unchanged during 1955 at 64½¢.

January 9

▲ The AISI reports that the operating rate of the steel industry for the week of January 9 is scheduled at 97.0 per cent of capacity. This is equivalent to 2,388,000 tons compared with 2,403,000 tons one week ago and 2,007,000 tons one year ago. Index of production for the week is 148.7.

▲ Payroll of the iron and steel industry during November was the highest for any month in history with an estimated total of $326,109,000, nearly $1,000,000 above October. Average payroll cost of wage earners in November was $2.615 for each hr compared with $2.600 in October and $2.391 in November 1954. Working hours averaged 40.6 hr per week compared with 39.4 hr per week in October.

▲ Dominion Foundries and Steel, Ltd. announced price increases on their hot rolled steel plate of $10 per short ton to $107 and on hot rolled steel sheet of $5 per ton to $95. This was due to recent increases in the price of steel scrap.

▲ Allegheny Ludlum shareholders approved a two-for-one split of their common stock. They voted to increase the firm's stock authorization from its present 2,500,000 to 10,000,000 shares.

▲ Zinc was raised ½¢ to 13½¢ per lb in East St. Louis following two recent increases in the price of lead which now sells for 16½¢ per lb.

▲ According to the Commerce Dept., personal income continued to climb in November when it reached an annual rate of $311,400,000,000 which was $2,200,000,000 above the October pace.

▲ Construction outlays in 1955 set a new high with December expenditures totaling nearly $3,200,000,000, off 12 per cent from November but 3 per cent higher than December one year ago. The 1955 total was $42,300,000,000, a 12 per cent increase over 1954.

January 10

▲ According to The Aluminum Association, primary production of aluminum in November dropped to 267,377,623 lb in comparison with 269,312,211 lb in October but an increase over November 1954's total of 242,503,923 lb.

▲ December employment was 2,500,000 higher than ever before for the month or 64,200,000.

▲ Shipments of iron and steel castings during October amounted to 1,547,000 short tons, according to the Bureau of the Census, Dept. of Commerce. This was 4 per cent above the September total and 41 per cent above the October 1954 total.

January 12

▲ Atlas Steels, Ltd. has joined with Mallory Sharon Titanium Corp. of Niles, Ohio in the formation of a titanium processing subsidiary called Atlas Titanium, Ltd.

▲ Reynolds Metals Co. has contracted with Ford Motor Co. to deliver 640,000,000 lb of aluminum during the next ten years. Reynolds will erect a new $80,000,000 plant at Listerhill, Ala. to produce the aluminum.

▲ General Tire acquired an interest in A. M. Byers Co., and a merger of the two companies is being considered.

January 13

▲ The New York Stock Exchange approved Ford Motor Co.'s application for listing. This covered 10,847,100 shares.

▲ According to The Aluminum Association, primary aluminum production in the U. S. for December totaled 281,496,030 lb in comparison with 267,377,623 lb in November and 254,069,331 lb in December one year ago.

▲ Scrap copper price has been reduced 1½¢ per lb to 40¢ per lb by custom smelters.

▲ The Commerce Dept. reported imports into the U. S. in November were 25 per cent over the year-ago totals. November's total imports were $1,053,000,000 in comparison with $839,500,000 in November 1954 and $1,009,800,000 in October 1955.

January 16

▲ The AISI reports that the operating rate of the steel industry for the week of January 16 is scheduled at 97.1 per cent of capacity. This is equivalent to 2,391,000 tons compared with 2,428,000 tons one week ago and 2,008,000 tons one year ago. Index of production for the week is 148.8.

▲ The F. W. Dodge Corp. reported contract awards for future construction in the 37 states east of the Rockies totaled $1,920,754,000 in December, up five per cent from December 1954. The total for 1955 reached an all-time high of $23,745,277,000 which was 20 per cent above the 1954 total.

▲ According to the AISC, the U. S. will ship an estimated 3,300,000 tons of fabricated steel work in 1956, approximately 12 per cent more than in 1955. Backlog of work ahead now stands at 2,000,000 tons which is about eight months' work.

▲ Lead price dropped ½¢ per lb after its recent hike of 1¢, and now stands at 16¢ per lb.

▲ Consumption of scrap and pig iron during November totaled 12,144,000 gross tons, a decrease from the October total of 12,636,861 gross tons, according to The Bureau of Mines, United States Dept. of the Interior. Scrap consumed in November totaled 6,308,000 tons.

January 17

▲ According to the Copper Institute, copper shipments totaled 1,439,758 tons compared with 1,208,755 tons shipped in 1954. December shipments amounted to 138,803 tons, a drop of 3004 tons from November.

▲ According to Benjamin F. Fairless, president of the AISI, steel companies in the U. S. plan to add about 5,000,000 tons to their steelmaking capacity each year for the next three years.

▲ Production of goods and services in 1956 is expected to reach $400,000,000,000 or about 4 per cent ahead of 1955, according to the president of General Motors Corp., Harlow H. Curtice.

January 18

▲ Ford Motor Co. announced it would place its first public issue of 10,200,000 shares of common stock on sale at $64.50 per share.

▲ Deliveries of new domestic freight cars in December totaled 3796 compared with 3427 in November and 2173 in December one year ago, according to the ARCI. Orders in December totaled 42,278, compared with November's record high of 51,066. Backlog of cars on order of January 1 stood at 147,320 cars.

January 19

▲ The General Services Administration will accept United Engineering and Foundry Corp.'s bid to purchase the Government's heavy machinery plant at New Castle, Pa. if approved by the Government Operations Committees of both houses of Congress.

▲ Altos Hornos de Mexico, S. A. has awarded a contract to John E. Greenawalt for a sintering plant to be built at Monclova, Mexico. Capacity is expected to be 900 tons of finished air cooled sinter per day, the first iron ore sintering plant in Mexico.

January 20

▲ Allegheny Ludlum Steel Corp. raised its prices on cold finished stainless steel bars and wire, and on stainless steel hot rolled wire rods, following the lead of other steel companies.

▲ Rotary Electric Steel Co. directors will ask stockholders to authorize an increase in the number of $10 capital stock shares outstanding from its present 750,000 shares to 2,500,000.

January 23

▲ The AISI reports that the operating rate of the steel industry for the week of January 23 is scheduled at 98.0 per cent of capacity. This is equivalent to 2,413,000 tons compared with 2,437,000 tons one week ago and 2,051,000 tons one year ago. Index of production for the week is 150.2.

January 25

▲ Shipments of gray iron castings in November amounted to 1,306,000 short tons, almost equal to October's shipments of 1,310,000 tons and 31 per cent above the November 1954 total, according to the Bureau of Census, Dept. of Commerce.

January 26

▲ U. S. Steel Corp., with its Columbia-Geneva Steel Div. and Tennessee Coal and Iron Div., announced revisions in its lists of extras for carbon steel plates, the heavier gages of hot rolled carbon steel sheets and for hot rolled carbon steel strip.

▲ The Industrial Heating Equipment Association reported 1955 furnace orders totaled $99,658,955 in comparison with the previous year's total of $46,330,169, an increase of nearly 116 per cent.

▲ Steel scrap prices dropped $2 per ton in Pittsburgh.

January 27

▲ Pittsburgh Coke and Chemical Co. announced the consolidation of its Coal Chemicals and Plasticizer divisions into a new Industrial Chemical division.

▲ The AISC reported December bookings of fabricated structural steel amounted to 367,827 tons compared with 345,308 tons in November and 196,767 tons in December one year ago. Shipments in December totaled 248,017 tons leaving a backlog of work ahead as of December 31 of 2,243,046 tons.

January 30

▲ Industrial materials prices increased steadily during the second half of 1955 and by early 1956 prices averaged 5 per cent above the year-earlier level, according to the Federal Reserve Board.

▲ The AISI reports that the operating rate of the steel industry for the week of January 30 is scheduled at 97.7 per cent of capacity. This is equivalent to 2,406,000 tons compared with 2,472,000 tons one week ago and 2,070,000 tons one year ago. Index of production for the week is 149.8.

January 31

▲ National Steel Corp. is operating at more than 100 per cent of capacity and indicates that it expects to remain at this capacity through at least the first half of 1956.

▲ Steel prices are expected to go up further in 1956 according to Roger M. Blough, chairman of U. S. Steel Corp.

▲ Losses at Westinghouse Electric Corp. amounted to $1,037,000 or 9¢ per share during the fourth quarter of 1955. They reported a net income of $42,803,000 or $2.46 per common shares on net sales of $1,440,977,000 for 1955 compared with a net income of $79,922,000 or $4.78 per common share on net sales of $1,636,184,000 during 1954.

▲ Allis-Chalmers Manufacturing Co. reported 1955 sales amounted to approximately $535,000,000 which is 9 per cent more than 1954. Earnings during 1955 were around $6.00 per common share.

STEEL COMPANY ANNUAL FINANCIAL REPORTS — 1955

	1955 Net sales	1955 Net profit	1955 Earnings per share	1954 Net sales	1954 Net profit	1954 Earnings per share
Acme Steel Co.	$ 109,000,000	.....	$ 3.00	$ 72,000,000	.....	$ 1.88
Alan Wood Steel Co.	.....	$ 2,552,000	.....	.....	$ 1,246,000	.....
Allegheny Ludlum Steel Corp.	255,587,054	14,985,660	8.25	170,056,405	4,246,083	2.30
Armco Steel Corp.	692,688,000	64,288,000	6.05	532,045,314	41,100,266	3.93
Barium Steel Corp.	75,553,000	702,000	0.22	53,484,603	—441,212	.....
					Loss	
Bethlehem Steel Co.	2,096,616,646	180,191,708	18.09	1,656,809,455	132,337,154	13.18
Colorado Fuel and Iron Corp.*	.....	7,952,683	2.49	.....	3,056,524	1.03
Copperweld Steel Co.	.....	2,365,459	.....	.....	703,150	.....
Crucible Steel Co.	237,715,380	13,208,602	8.05	160,621,738	3,705,952	2.26
Granite City Steel Co.	116,294,000	12,611,000	6.05	69,265,000	4,012,000	2.04
Inland Steel Co.	663,317,374	52,466,098	9.52	537,024,479	41,287,152	7.92
Interlake Iron Corp.	100,000,000	8,500,000	4.38	66,000,000	3,100,000	1.61
Jones and Laughlin Steel Corp.	696,538,000	50,104,000	7.73	492,941,000	25,032,000	3.80
Kaiser Steel Corp.*	73,239,702	3,913,575	0.87	53,729,130	—710,744	—0.58
					Loss	Loss
Keystone Steel and Wire Co.	26,639,447	2,191,550	1.17	20,984,795	1,938,388	1.03
Lone Star Steel Co.	74,489,000	4,759,000	1.80	38,428,000	—1,009,000	—0.39
					Loss	Loss
McLouth Steel Corp.	.....	8,148,000	.....	.....	1,695,000	.....
National Steel Corp.	622,018,919	48,289,453	6.54	484,058,380	30,334,871	4.12
Pittsburgh Steel Co.	176,732,000	7,515,000	4.31	123,965,000	2,170,000	0.62
Republic Steel Corp.	1,188,559,765	86,271,491	5.59	846,310,670	52,875,164	3.55
Rotary Electric Steel Co.	.....	3,772,074	.....	.....	1,849,810	.....
Sharon Steel Corp.	173,095,949	7,987,622	7.26	.....	3,134,864	2.85
Steel Co. of Canada	227,005,261	21,818,638	5.89	176,571,148	13,231,059	3.57
Superior Steel Co.	37,974,000	1,716,900	4.90	26,224,000	532,900	1.28
United States Steel Corp.	4,097,713,312	370,197,625	6.45	3,250,369,279	195,417,611	3.23
Wheeling Steel Corp.	246,695,000	17,296,000	8.12	187,571,957	9,595,740	4.98
Youngstown Sheet and Tube Co.	626,998,840	41,701,140	12.34	433,406,272	20,182,500	6.02

*Figures for six month period ending December 31.

FAST···LEGIBLE BILLET MARKING!

now made possible with the NEW

MODEL 701 PNEUMATIC BILLET MARKER

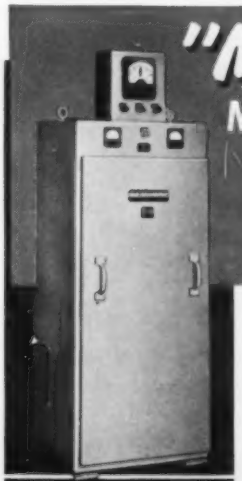
This new, compact unit stamps ends of billets 4" x 4" or larger with a deep, legible mark as shown above. Unit is mounted on an I-beam track and powered by heavy duty air cylinder. Quick change type holder is kept in stamping position at all times without special guides.

WRITE for complete data.

Mecco SAFETY MARKING TOOLS M.E.CUNNINGHAM CO.

1041 CHATEAU STREET, PITTSBURGH 33, PA.

"MEASURAY" MEASURES THICKNESS ACCURATELY without TOUCHING the MATERIAL



Hot or Cold Strip Steel, Brass, Copper, Aluminum . . . Plastics, Foils, Coated Fabrics, Film, Rubber, Etc., Even When Moving At High Speed.

Simple method—the "Measuray" shoots X-Rays through the material—measures its absorption of the rays. Calibrated meter registers plus or minus per cent of deviation from pre-determined standard. Especially useful on hot mills where material can't be checked by contact gages. Also when material can be deformed by contact such as foil.

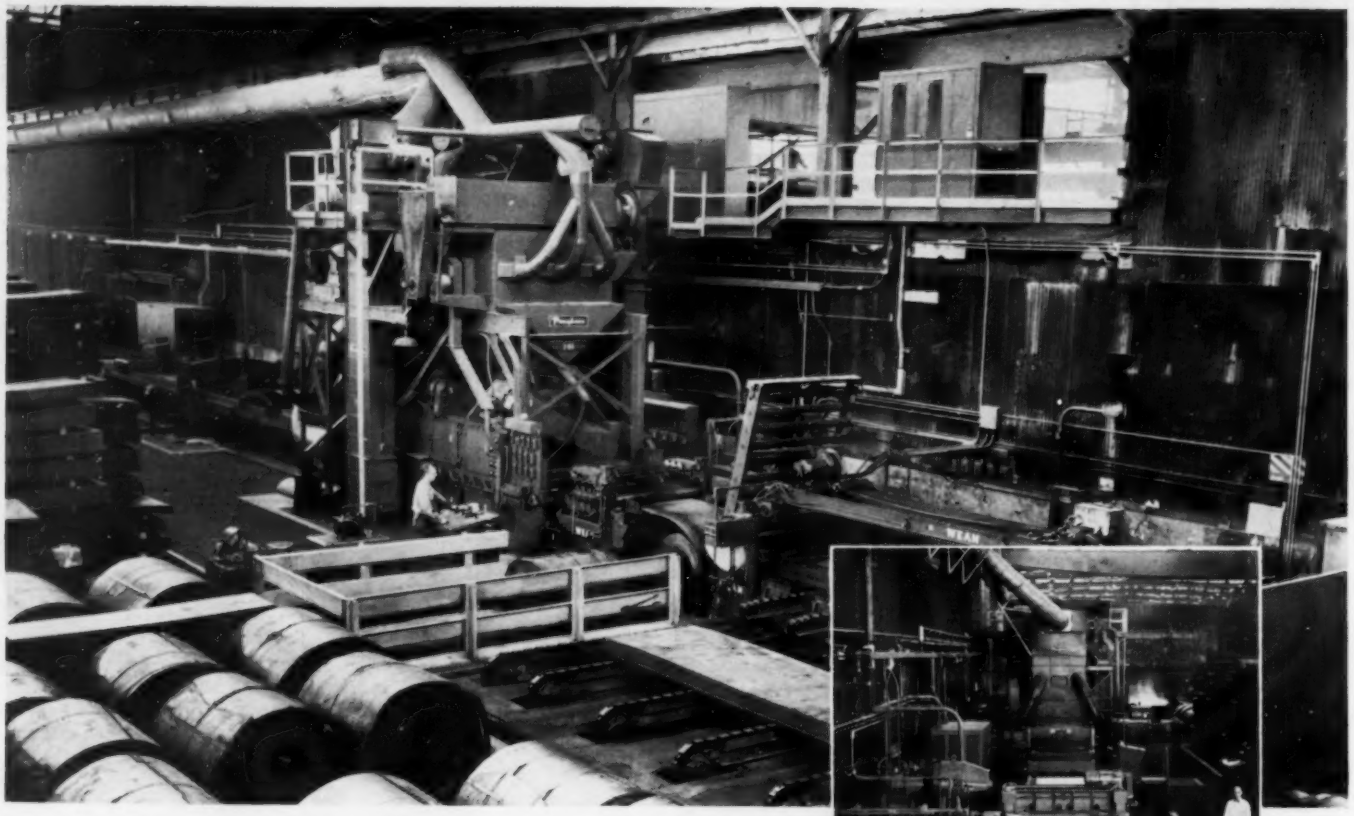
"Measuray" is accurate to 1% of thickness or less. Quickly pays for itself in reduced scrap.

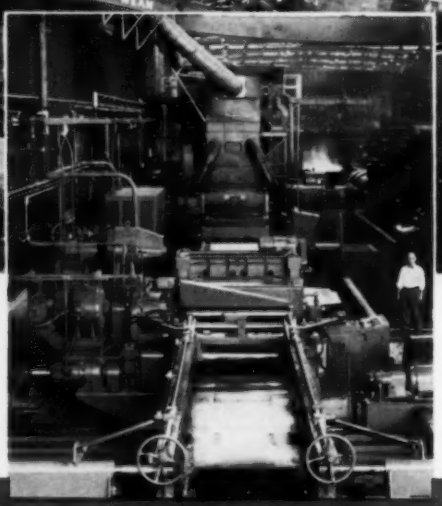
Write Today for Literature to Dept. 510, The Sheffield Corporation, Dayton 1, Ohio

GOLDEN ANNIVERSARY

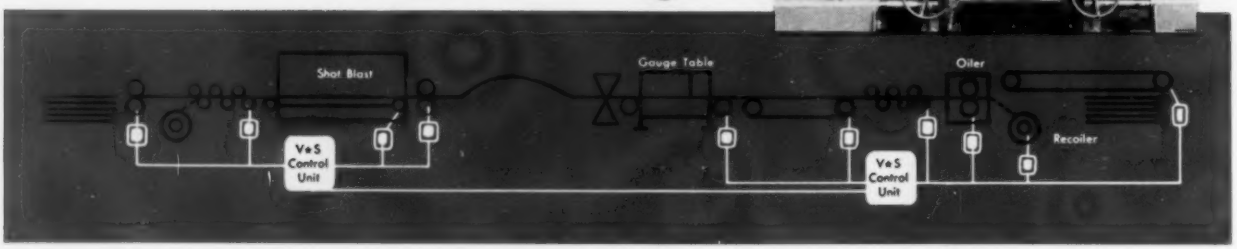
SHEFFIELD

manufacture and measurement for mankind





CUTS AND CLEANS UP TO 50 TONS AN HOUR— *Automatically*



It's one of the world's first automotive steel cut-up lines, owned by Parish Pressed Steel Div.—Dana Corp., Reading, Pa. This line cleans, cuts-to-length, lubricates, levels, and coils or stacks up to 50 tons of hot rolled steel an hour.

The line is made up of several separate machines —an uncoiler, a shear, a shot-blast cleaning machine, an unpiler, a lubricator, and a coil winder or stacker —all joined by a conveyor system containing pinch rolls and leveling rolls. Yet the whole line operates as one giant machine, thanks to perfect coordination provided by Reliance V★S Drives.

V★S Drives furnish an unusual flexibility to the Parish line too. Sheet speeds can be varied from 40 feet per minute up to 160 fpm. to accommodate various thicknesses and widths. From the master control, and the three supporting control stations, any one operation or combinations of operations can be eliminated from the line. Thus the line is not limited to just one set series of functions.

This application of Reliance Motors and Drives —to control tension, to synchronize operations, to regulate speed—is typical of the jobs done by the Reliance Applied Engineering Department.

L-1511

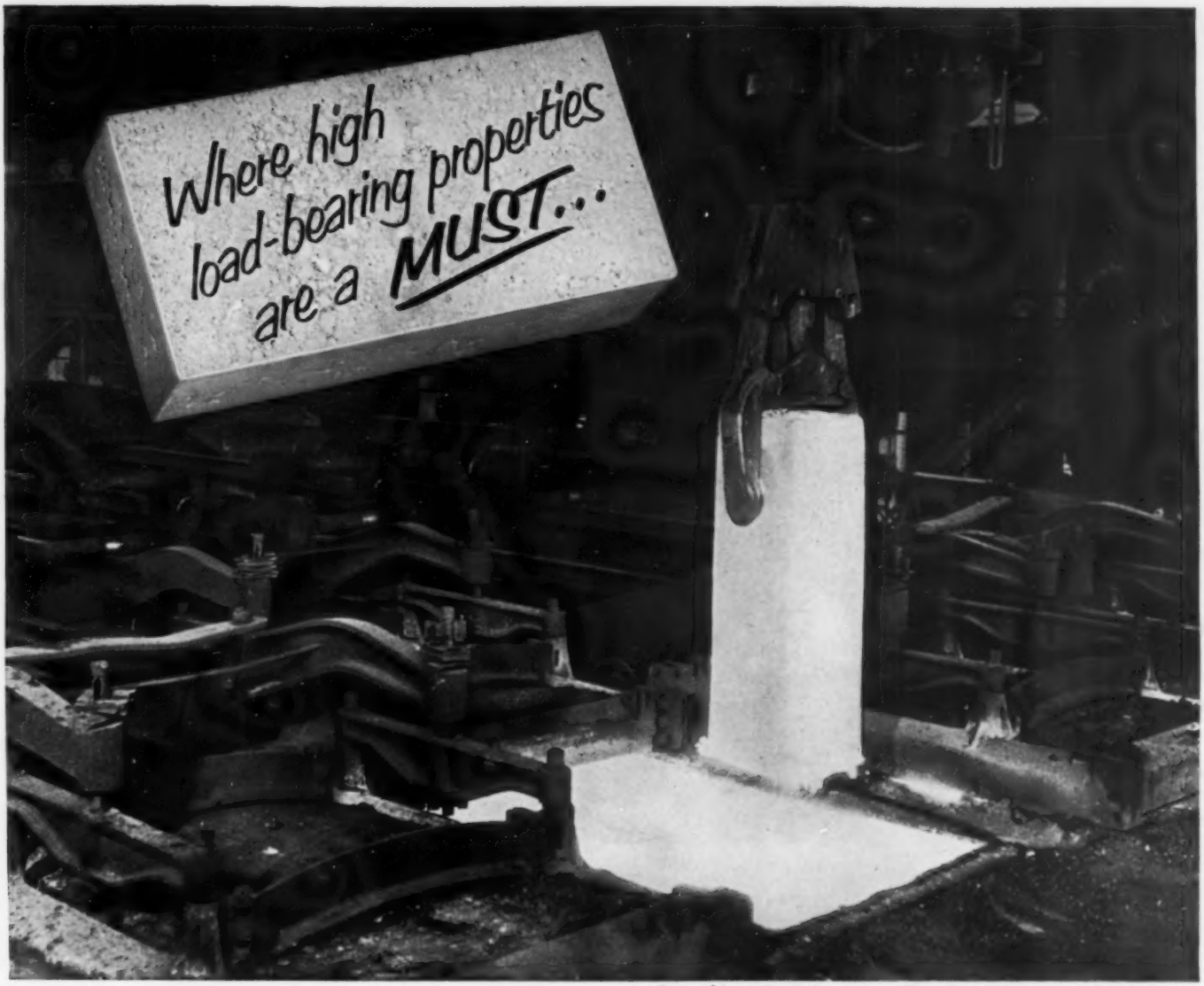
If you would like further information on the application of V★S Drives in your plant write:

RELIANCE V★S DRIVE®

RELIANCE ELECTRIC AND ENGINEERING CO.

Cleveland 10, Ohio • Offices in Principal Cities

Canadian Division: Welland, Ontario



In soaking pits, Johns-Manville Sil-O-Cel C-22 Insulating Brick provide outstanding performance as back-up insulation.

Specify

Johns-Manville SIL-O-CEL C-22 Insulating Brick

the diatomaceous silica brick that retains its high cold crushing strength of 700 psi throughout normal service range

Because of its exceptional strength Sil-O-Cel C-22 Insulating Brick has gained wide acceptance as an all-purpose insulating brick. It is especially recommended for soaking pits, open hearth bottoms, slab heating furnaces, hot blast stoves, coke ovens and other high temperature equipment.

Millions of microscopic cells provide Sil-O-Cel C-22 brick with excellent heat resistance up to 2000F. It has a thermal conductivity of only 1.88 Btu in/sq ft/F/hr at 1000F mean temperature. In addition, with a density of 38 lb/cu ft, it is light and easy to handle.

For direct exposure or back-up to 1600F, use Sil-O-Cel 16L Insulating Brick. This newest member of the J-M diatomaceous silica insulating brick family has *less than 0.1% reversible thermal expansion at 1600F.* Conductivity is 1.07 Btu in/sq ft/F/hr at 1000F mean temperature with a density of 33-35 lb/cu ft. Cold crushing strength is 350 psi. Sil-O-Cel 16L serves equally well as back-up insulation or exposed refractory lining.

For back-up at higher temperatures, specify Sil-O-Cel® Super Insulating Brick with an unusually high temperature limit of 2500F.

Write today for further information on Sil-O-Cel Insulating Brick and Insulating Fire Brick. Ask for Brochure IN-115A. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, 565 Lakeshore Road East, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *first-in* INSULATION

MATERIALS · ENGINEERING · APPLICATION

For iron-ore sintering...

Koppers designed and constructed

SINTERING becomes a more vital consideration each day to production men who must meet the heavy demand for steel. Sinter makes it possible to obtain maximum production from existing blast furnaces. By economizing on coke rate, it also squeezes the most out of the available coke supply.

Koppers designed and constructed the machine shown here for the Weirton Steel Company, Weirton, West Virginia —a division of National Steel Corporation. It is the *first* 8-foot-wide sintering machine in the United States. It has the capacity to make more iron-ore sinter than any other machine in the country.

Weirton Steel's new machine is sintering fines from Labrador ore as well as from Great Lakes ore. It is producing good quality sinter for the company's blast furnaces.

Designing and constructing sintering plants is just one way in which Koppers serves the steel industry. For any kind of metallurgical construction, **you can count on Koppers.** You are invited to consult with our Engineers and Management.

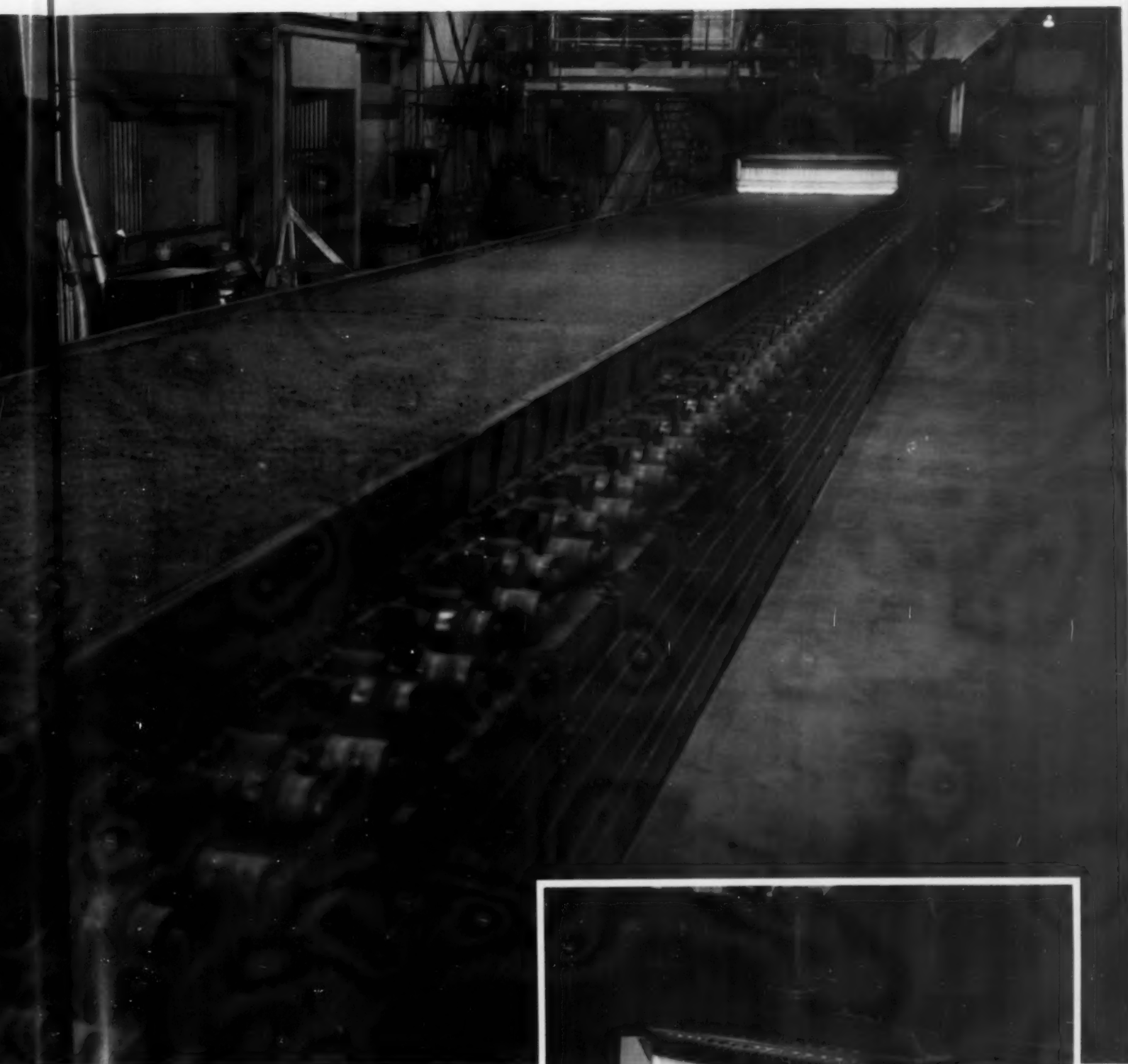
NATIONAL ENGINEERS' WEEK
Engineering ... BUILDER OF A BRIGHTER FUTURE

KOPPERS®

Engineering and Construction Division
FREYN DEPARTMENT
American Ore Reclamation Section

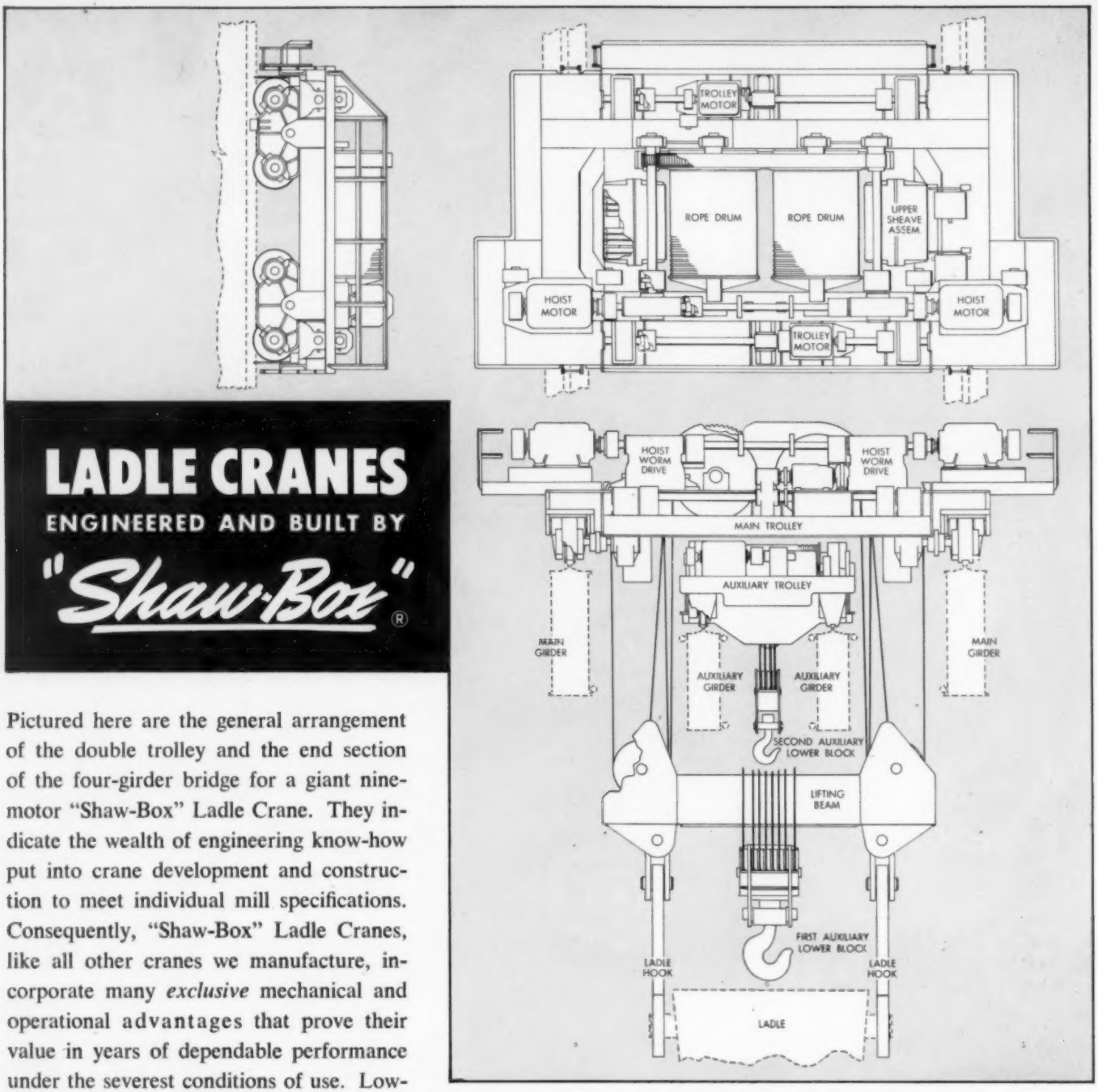
KOPPERS COMPANY, INC., PITTSBURGH 19, PENNSYLVANIA

ed largest machine in United States



▲ View of Weirton Steel's new 8-foot sintering machine, looking toward feed end. It is the widest iron-ore sintering machine in the United States.

Inset shows ignition furnace and vibrating spreader feeder, which eliminates conventional swinging spout. ▶



LADLE CRANES

ENGINEERED AND BUILT BY "Shaw-Box"®

Pictured here are the general arrangement of the double trolley and the end section of the four-girder bridge for a giant nine-motor "Shaw-Box" Ladle Crane. They indicate the wealth of engineering know-how put into crane development and construction to meet individual mill specifications. Consequently, "Shaw-Box" Ladle Cranes, like all other cranes we manufacture, incorporate many *exclusive* mechanical and operational advantages that prove their value in years of dependable performance under the severest conditions of use. Low-cost operation, complete safety, and simplified maintenance likewise help make every "Shaw-Box" Steel Mill Crane a continuously productive investment in load-handling efficiency.

Whether your plans call for a ladle crane of 100 to 400-ton capacity, a soaking pit carriage, or a crane to handle slabs or plate, we invite your inquiry. Our staff of engineers will gladly apply their varied experience in interpreting AISE specifications or your own. In this way, you can make sure you get individualized equipment that will be the most economical to buy and use.

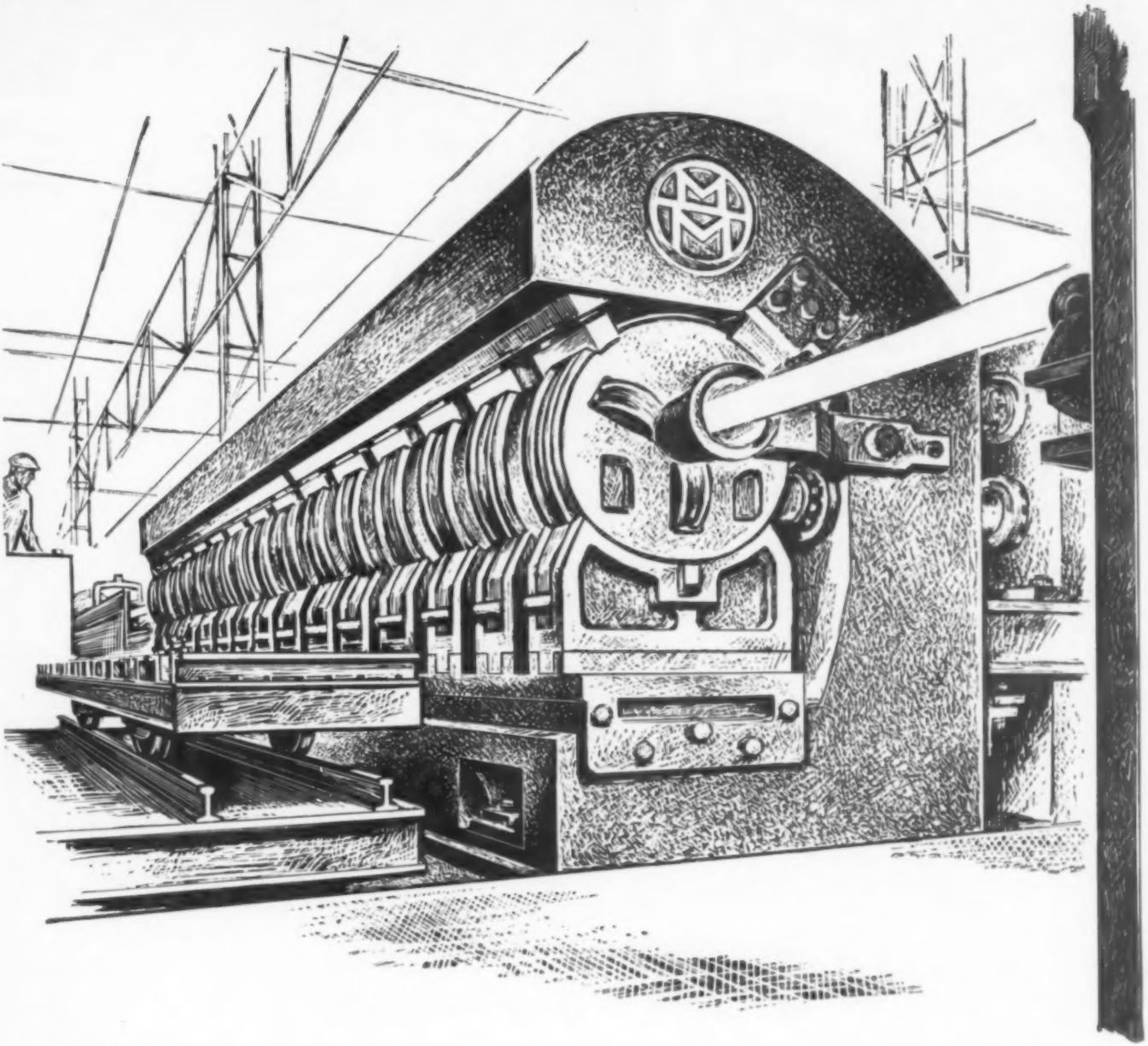
MAXWELL MANNING M&M & MOORE INC. TRADE MARK

"Shaw-Box"® CRANES

MANNING, MAXWELL & MOORE, INC.

Muskegon, Michigan

BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES. MAKERS OF 'ASHCROFT' GAUGES, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, AND AIRCRAFT PRODUCTS.



Want Higher Pipe Production?

Stretch reducing to increase tonnage rating of existing pipe welding mills or to increase the potential output of new mills is one of the recent production improvements at Mannesmann-Meer. Welding or rolling large diameter standard sizes boosts tonnage of the original mill and puts the stretch mill to work to produce the smaller sizes.

But that's only half of the story. By applying the 3-roll arrangement to the stretch reducing mill, greater diameter and outstandingly high wall reductions together with an improved mill finished product have been made possible. Moreover, basic changes in overall mill design include a revolutionary new mill drive and an ingenious roll stand arrangement to suit today's need for extremely fast schedule changeover.

Plan ahead and develop today what you will ask for tomorrow is Mannesmann-Meer's approach to the problems of the pipe and tube industry. This leads to the design of equipment incorporating a combination of

- CREATIVE ENGINEERING
- DESIGN EXPERIENCE
- OPERATING BACKGROUND
- AMERICAN MANUFACTURING SKILL

which is nowhere else available and ready to answer your questions.

MANNESMANN-MEER

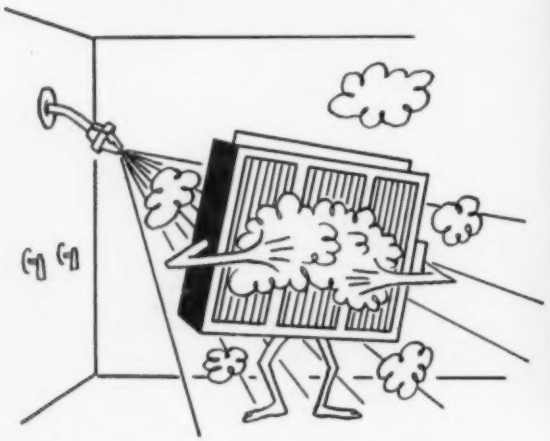
ENGINEERING AND CONSTRUCTION COMPANY, 900 LINE STREET, EASTON, PENNA

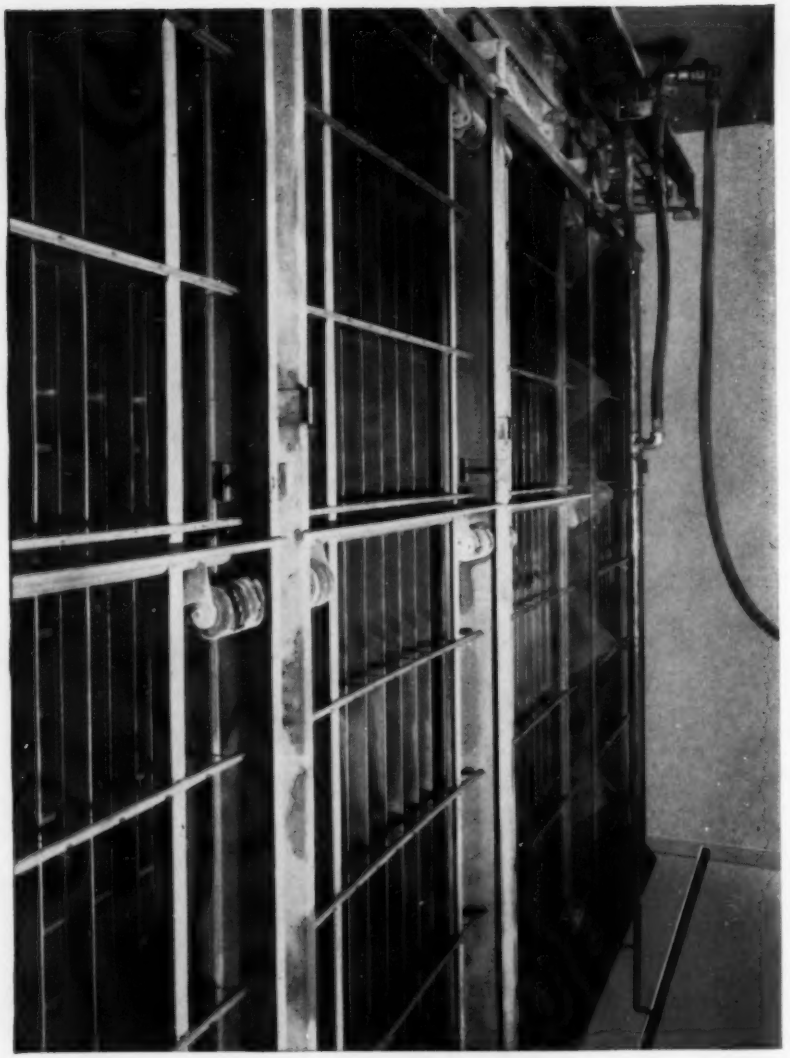
WORLD SPECIALISTS IN HIGH-SPEED TUBE MILL MACHINERY

Electro-CELL PRECIPITATOR

HAS ITS OWN

PRIVATE SHOWER





Type H Washer Makes AAF Filter "Come Clean" at the Push of a Button

A man to press one button periodically! That's all it takes to keep an AAF Electro-Cell with Type H Washer as "clean as a whistle". This means super-clean air around the clock, with no maintenance worries.

This electrostatic precipitator has its own private shower consisting of a set of traveling spray nozzles. At a press of the button, they move back and forth across the collector plates. Spray heads are automatically adjusted to point at a 5-degree angle in the direction they are traveling, insuring that each side of each individual plate is washed thoroughly.

This high efficiency precipitator collects dust, soot and smoke as a routine assignment, maintains this efficiency at minimum cost and effort. Ask your local AAF representative for all the facts on Electro-Cell with Type H Washer, or write direct for Bulletin 252-E3A.

AAF American Air Filter
COMPANY, INC.
302 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q.

AAF Filters and Precipitators

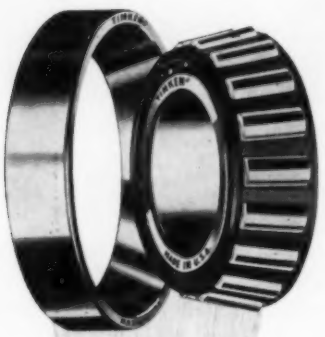
AAF Dust Control Equipment

BETTER AIR IS OUR BUSINESS

Herman Nelson Unit Heaters

Illinois Steam Heating Specialties

NOW from Bearings, Inc.

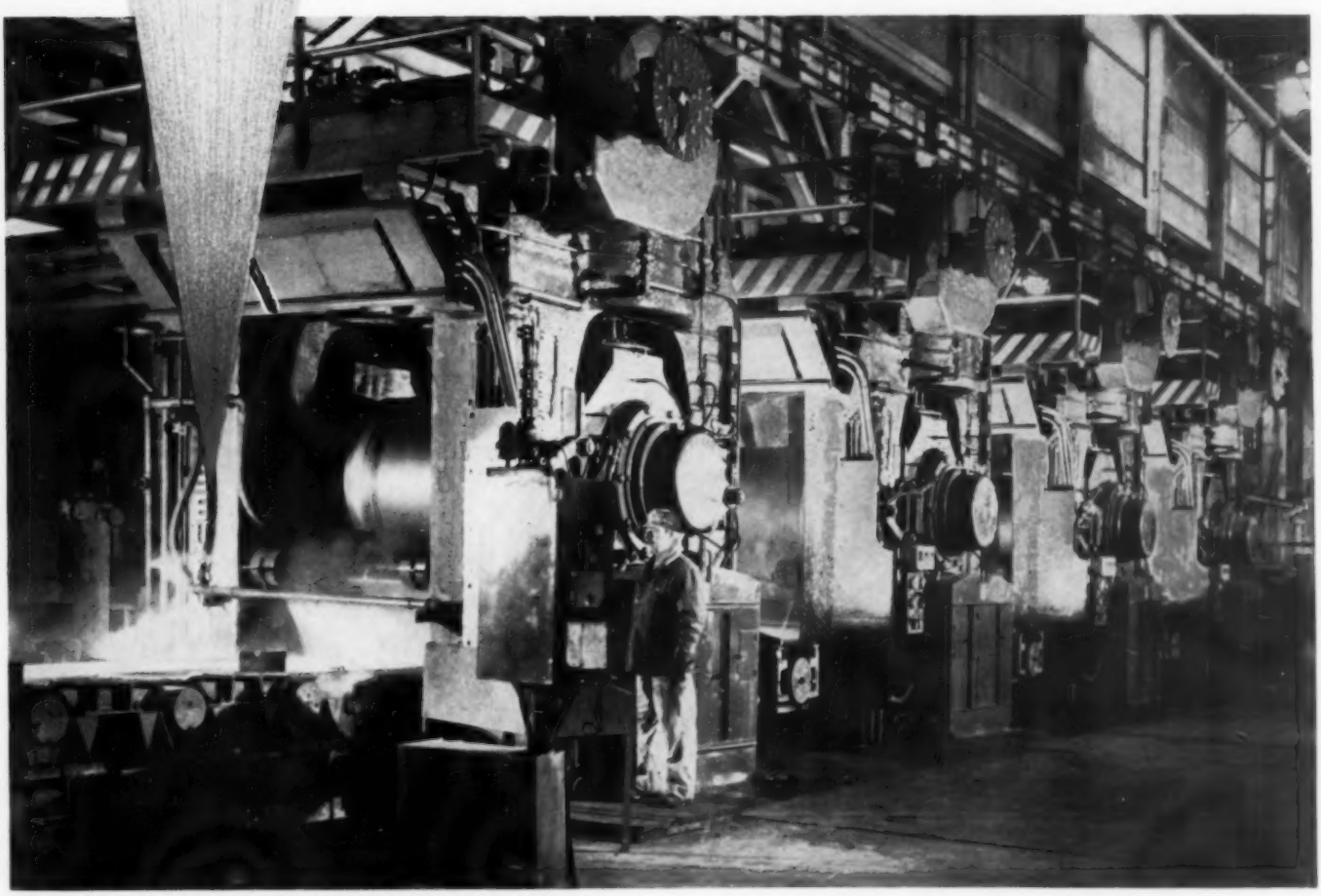


TIMKEN . . . for ALL Steel Mill Applications on or off the Mill !!!

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

Now you can get the quick, hurry-up service you have come to expect from Bearings, Inc. on the most critical replacement bearings in the mill! Timken® Tapered Roller Bearings for roll necks, pinion stands, coilers and table rolls can now be supplied by Bearings, Inc. — Service is available from the branch in the city nearest you! Contact a Bearings, Inc. Engineer — he'll be glad to talk over long range requirements for Timken® Tapered Roller Bearing replacements.



Timken is a registered trademark of The Timken Roller Bearing Co.

Bearings, Inc.

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INDIANA: Ft. Wayne • [illegible] • Muncie • Terre Haute

PENNSYLVANIA: Erie • Jo[illegible] • Philadelphia • Pittsburgh • York

WEST VIRGINIA: Charleston • Huntington • Wheeling

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BEARINGS, Inc., 3634 Euclid Ave., Cleveland 15, Ohio

Gentlemen:

Please send us complete information on Timken steel mill bearings.

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Delivers 33,962 Amperes to The Timken Company

For Specialized Steel Production

This is one of three arc furnace transformers built by Allis-Chalmers for The Timken Roller Bearing Company, Canton, Ohio, plant.

The repeated daily short circuits encountered in arc furnace operation require exceptionally rugged transformers that can provide reliability over long periods. That's one reason Allis-Chalmers furnace transformers are chosen for jobs like this. They have served many furnaces for as much as 25 to 30 years.

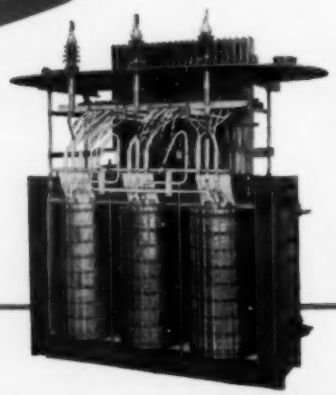
Design Features

Extremely heavy supports brace the coils against short circuit stresses in these transformers. Skillful insulation techniques protect windings from overvoltages due to wide tap range. Some of these transformers have been built with a range of operating voltages of several times the minimum secondary voltage.

The tap changer has specially designed contacts to provide for long life regardless of numerous daily tap changes. The mechanism is located in a separate compartment to facilitate inspection. It can either be motor driven or manually operated or both.

Complete Line of Arc Furnace Equipment

In addition to furnace transformers in ratings up to the largest demanded by expanding arc furnace operation, Allis-Chalmers also builds electrical control, circuit breakers, and auxiliary transformers. Next time you need new or replacement arc furnace electrical equipment, consult the Allis-Chalmers office nearest you or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4750



Rugged Core and Coil Assembly design is based on Allis-Chalmers more than 45 years' experience building arc furnace transformers. Unit must withstand repeated short circuits.

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

Industry News...

AMERICAN STEEL & WIRE DIVISION TO BEGIN CONSTRUCTION ON NEW WELDED WIRE FABRIC MILL

▲ Construction will begin in March on a new welded wire fabric mill for U. S. Steel Corp.'s American Steel & Wire Division, adding up to 40,000 tons of finishing capacity annually to Cuyahoga Works.

The new plant, which will cover almost 53,000 sq ft, is being built in Cleveland, and is part of American Steel & Wire's expansion for this construction steel. New facilities for its manufacture recently have been installed in its Joliet, Ill., and Duluth, Minn., plants.

The fabric, which looks like a large grill, will be manufactured in widths up to 13 ft. The welding machines which turn out the fabric in continuous lengths will be capable of producing a pattern with squares as small as two in. The fabric will be made of wire ranging in thickness from .135 in. up to ½ in. in diameter.

In addition to the new main building, there will be construction of warehouse facilities, and replacements of wire drawing equipment in existing wire mills to accommodate the new mill's wire needs.

Ground breaking for the new mill is expected to take place sometime during the first half of March. Plans call for the mill to be completed and in production within a year, according to Floyd A. Garman, chief engineer of the Wire Division.

FORM CANADIAN CO. TO PRODUCE TITANIUM

▲ Mallory-Sharon Titanium Corp. and Atlas Steels, Ltd., of Welland, Ontario, have joined forces to form a subsidiary company, Atlas Titanium, Ltd., which will supply titanium in bar, wire, sheet, strip, and forged forms for Canadian and world markets.

Atlas Steels, Ltd. will have the controlling interest in the new company. During the past two years, Atlas has processed considerable titanium for Canadian and U. S. contractors. The company's capacity is sufficient to allow the addition of titanium processing in volume without interfering in any way with present or anticipated tool and specialty steel output. The company's mill equipment is ideal for titanium processing and will require only minor additions for handling titanium.

Mallory-Sharon will furnish technical knowledge and assistance for the new firm, and for the present will melt and produce ingots for shipment to Atlas for further processing. All phases of production except melting will be carried out at Atlas Titanium on existing equipment. Aim of the new company is to help make Canada self-sufficient in its supply of titanium.

Among the directors elected for Atlas Titanium are James A. Roemer, president of Mallory-Sharon Titanium Corp., and Joseph E. Cain, president of P. R. Mallory & Co., Inc., one of Mallory-Sharon's parent companies. Other directors are R. H. Davis, H. G. DeYoung, and A. G. Howey, all of Welland, Ontario.

BRIDGE BEARING

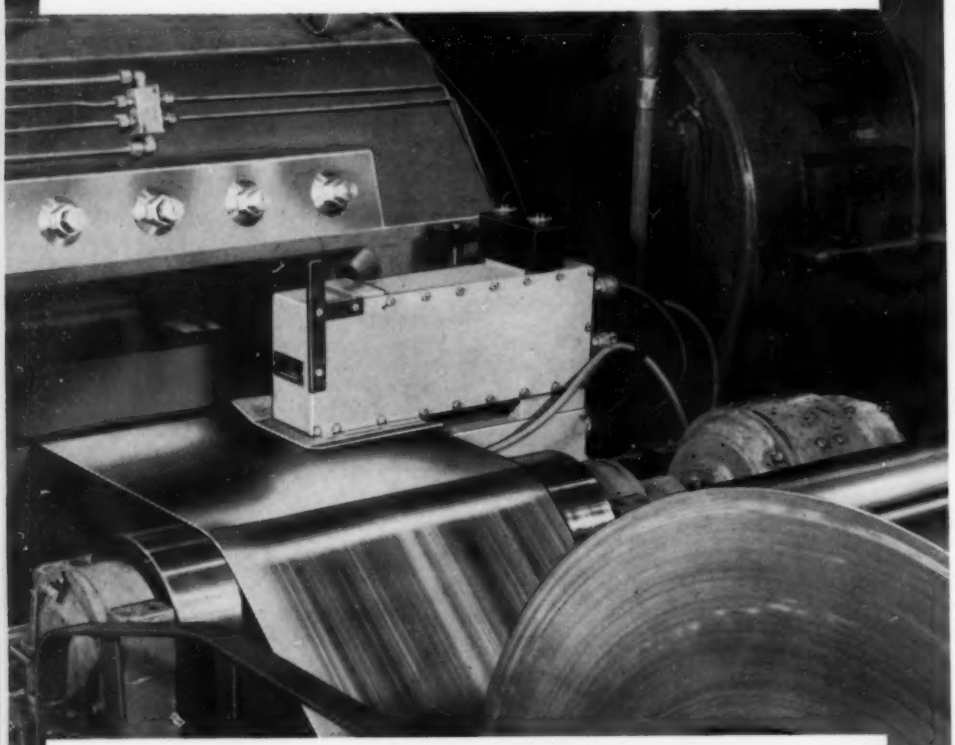
Workmen at the Ambridge, Pa., plant of U. S. Steel's American Bridge Division, steady the trunnion of a giant bearing as it is fit into place and readied for shipment. Two of these 15-ton bearings will carry the lifting load of a 255-ft span of a new Baltimore and Ohio Railroad draw bridge in Cleveland, Ohio.

GERMAN STEEL PLANT INSTALLS DOWNCOILERS

Two expanding mandrel type downcoilers, built by E. W. Bliss Co., have been installed in the West German steel plant of August Thyssen-Hutte A.G. at Duisburg-Hamborn. In this design, the coil ID is gripped tightly by the rotating mandrel, maintaining tension on the strip and winding a tight, smooth-edged coil. The Thyssen-Hutte coilers handle strip in widths from 24 in. to 60 in. on 28 in. diameter mandrels. Maximum coil OD is 56 in. The two upenders were also designed and built by Bliss.

STRIP MILL PRODUCTION *rolls ahead with* PRATT & WHITNEY Continuous Gages

ORIGINATORS OF THE "FLYING MIKE" IN 1930, P&W CONTINUES TO CONTRIBUTE IMPORTANTLY TO MODERN DEMANDS FOR FASTER SPEEDS, HIGHER QUALITY AND LOWER COSTS THROUGH IN-PROCESS GAGING OF STRIP AND AUTOMATIC CONTROL OF THE MILL



Take advantage of Pratt & Whitney's many years of experience in the design, manufacture and successful application of mill gages; a P&W Engineer is available to analyze your gaging problems, recommend the *right* equipment, and provide expert application engineering service. Complete, integrated, packaged systems — gages, controls and all other components — for fully automatic process control are available. Write today outlining your requirements.

PRATT & WHITNEY COMPANY
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28 Charter Oak Boulevard, West Hartford 1, Connecticut
Branch Offices and Engineers in Principal Cities
MACHINE TOOLS • GAGES • CUTTING TOOLS

ANNOUNCES EXPANSION FOR CHEMICALS DIVISION

▲ A $3,000,000 expansion program which will substantially increase its capacity to produce refractory and magnesia products has been scheduled by Kaiser Aluminum & Chemical Corp.'s Chemicals Division, according to Frank M. Cashin, vice president and manager of the division.

New facilities will be added to two of the division's plants — the Moss Landing, Calif., seawater magnesia plant and the Columbiana, Ohio, basic refractories plant now under construction.

New equipment for Moss Landing will double the present seawater handling capacity and will increase by more than 50 per cent its capacity to produce periclase. A large new rotary kiln will be installed at the seawater plant. This will have a capacity of approximately 150 tons of magnesia products per day, bringing total daily kiln capacity to approximately 375 tons a day.

New equipment at Columbiana will include additional pressing and materials handling facilities, which will increase the plant's capacity by 50 per cent. The Columbiana plant, presently under construction, is scheduled to be in operation by June 1, and the additional facilities will be installed by January 1, 1957.

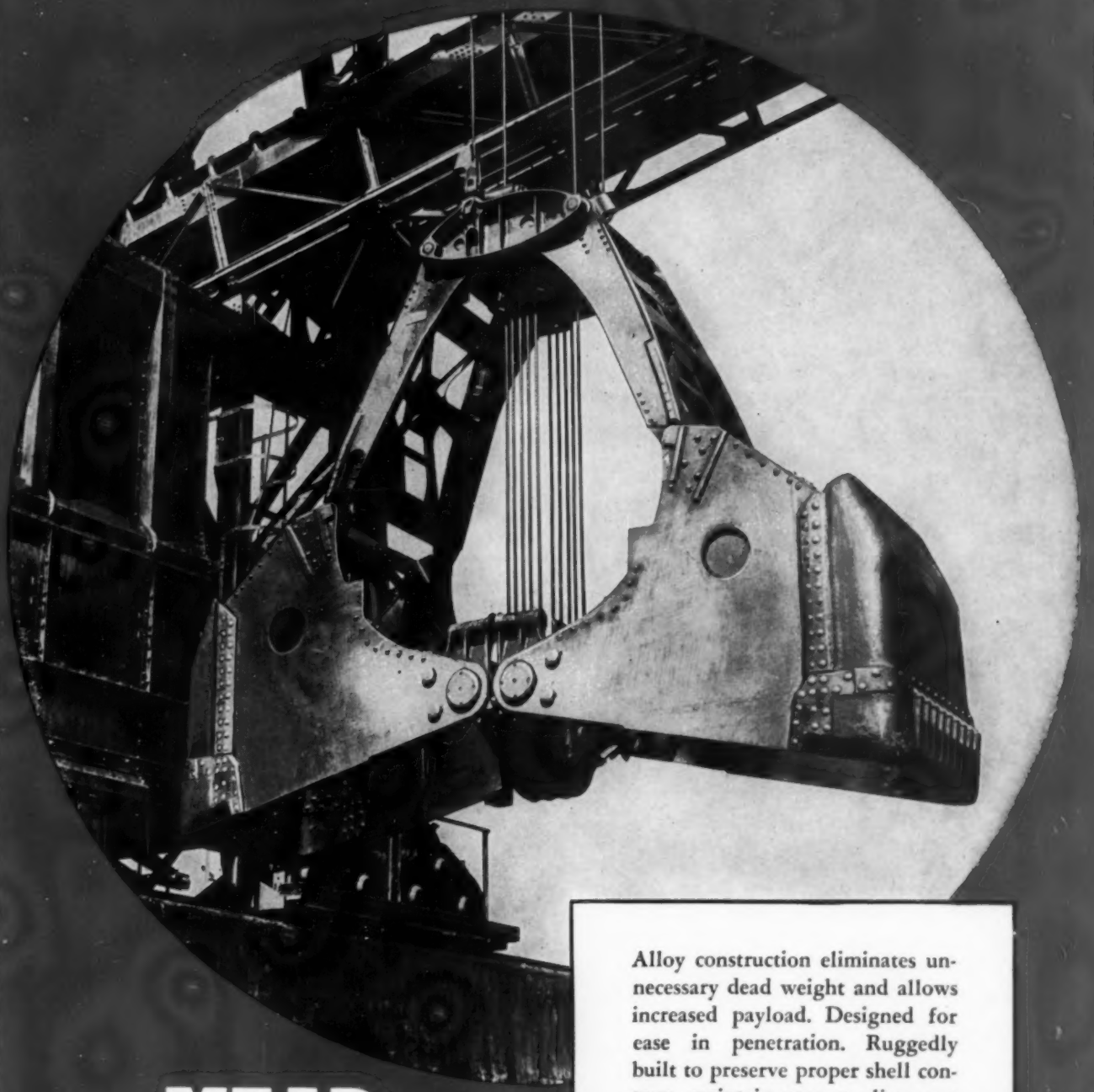
BEGIN WORK ON HEAT TREATING FACILITIES

▲ New heat treating facilities are being installed to increase production of stainless steel and special alloy plates at U. S. Steel Corp.'s Homestead District Works.

A heat treating line to be housed in a new building has been designed primarily to quench and temper alloy and stainless steel plates for highly specialized applications in either civilian or military end uses.

Removal of yard tracks near the 160-in. plate mill to make room for the construction of a building to house the new facilities is now under way. The framework of the new 858-ft long structure will require 1600 tons of structural steel that will be rolled at the plant's structural mill and then fabricated and erected by the American Bridge Division. The

MEAD-MORRISON Ore Buckets



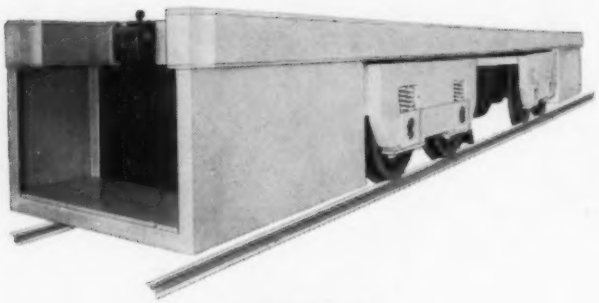
Alloy construction eliminates unnecessary dead weight and allows increased payload. Designed for ease in penetration. Ruggedly built to preserve proper shell contour, maintain correct alignment of bottom head and shell and withstand operating abuse.
Designs to operate at ends of lines and bight of line in a range of sizes. Also clean-up grabs.
Write for full information.

MEAD-MORRISON

Division of
McKIERNAN-TERRY CORPORATION
Manufacturing Engineers • Harrison, N. J.

Also builders of coal and ore bridges, bulk material unloaders, pile hammers, and specially designed machinery

Built to take a beating!



Phillips motorized transfer cars

Even under the most adverse conditions, Phillips Motorized Transfer Cars will provide extra long service life because extreme durability has become a design feature as with all Phillips equipment. Each unit is custom engineered to fit individual requirements. Motive power may be battery, gas electric or external electric. Capacities—15 tons up. Write, wire or phone Phillips for full details and prices.

SALEM-BROSIUS, INC.

18 Arch Street • Carnegie, Pa.

PHILLIPS MATERIALS-HANDLING EQUIPMENT

Manufacturers Since 1863

building will be 75-ft high and 110-ft wide covered with galvanized steel panel sheets.

The new plate mill equipment includes two continuous heating and hardening furnaces with a high-pressure water quenching system, a separate in and out furnace for stainless steel plates, processing tables, two 25-ton Gantry cranes, a roller leveler and piling beds.

CRUCIBLE TO INSTALL NEW MILL AT MIDLAND

▲ A 50-in. Sendzimir reversing cluster mill will be installed by Crucible Steel Co. of America at its Midland, Pa., works for cold rolling stainless and titanium strip. Installation of the $2,500,000 mill is scheduled for completion in 1957.

In addition to the width of product rolled, the new mill will have other valuable features. A power-operated roll crown adjustment to control the contour of the strip, as compared to manual operation in other mills of this kind, will decrease down-time for adjustment of work rolls to a minimum, by making adjustments while the mill is operating.

The new mill will also incorporate a tension measuring device which will be one of the first of its kind on any cold mill of this size rolling titanium or stainless steels. Tension is ordinarily measured by the amount of hp utilized from the motor driving the take-up reel. This new development will have a means of direct measurement of tension by the use of a tension indicator which will be calibrated to indicate tension on a meter visible to the operator.

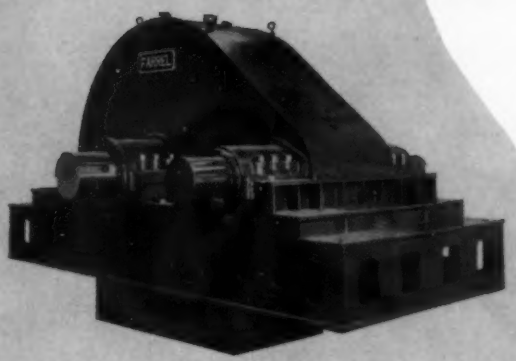
ANNOUNCES PURCHASE OF W. E. MOORE & CO.

▲ Purchase of the principal assets of W. E. Moore and Co. and four affiliated Pittsburgh concerns by McGraw Electric Co. has been announced. The acquisition includes all plant buildings and property of the several firms, as well as equipment, patents, designs, and other related items that will enable McGraw to continue operations.

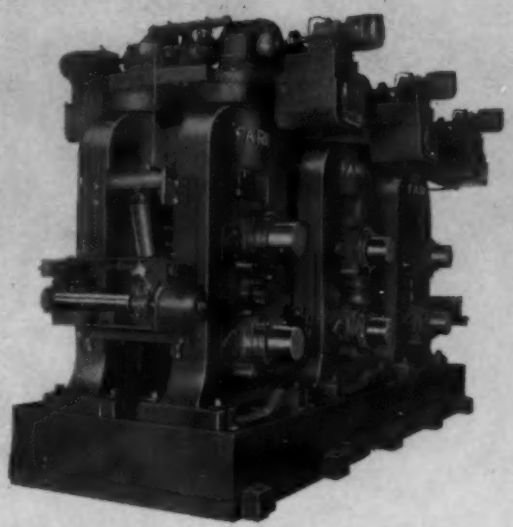
The business consists of the engineering, design and manufacture of steel melting furnaces, sold under the

(*Please turn to page 150*)

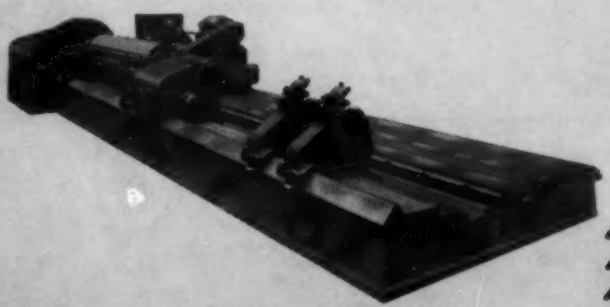
Rx FOR ROLLING MILL HEADACHES



5500 HP Herringbone geared reduction unit designed to transmit power to a 134" three-high, sheared plate mill.



4½" and 14⅝" x 16" four-high, three-stand tandem mill for rolling nonferrous strip.



Farrel heavy-duty roll grinder.

ROLLING MILLS — For almost a century, Farrel mills have been helping to solve rolling mill production problems. They are built in a wide range of types and sizes for rolling nonferrous rods, strips or sheets, metal foils and cold strip steel. Farrel also designs and manufactures coilers and special handling equipment required to make each installation a complete production unit.

MILL DRIVES — Specially designed to suit individual requirements, Farrel reduction gear drives, pinion stands and combination units are built in any size for any capacity. Combination units have the reduction gears and mill pinions in a compact, integral housing.

ROLL GRINDERS—Available in two types and nine standard sizes, Farrel roll grinders enable you to fix and maintain definite standards of accuracy and finish. Rolls are produced with a flawless surface, free from marks of any kind, ground straight, or with concave or convex contours of exact symmetry and accuracy.

Information and engineering consultation available, without obligation.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

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Sales Offices: Ansonia, Buffalo, New York, Akron, Chicago, Fayetteville (N. C.), Los Angeles, Houston

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Rolls • Rolling Mills • Slab, Rod and Coil Handling Equipment • Universal Mill Spindles • Rod Coilers • Slitters • Gears • Mill Pinions • Pinion Stands • Gear Drives of Any Capacity • Flexible Couplings • Roll Grinding Machines • Roll Calipers

Farrel-Birmingham®

FB-1053

GENERAL ELECTRIC *Control*

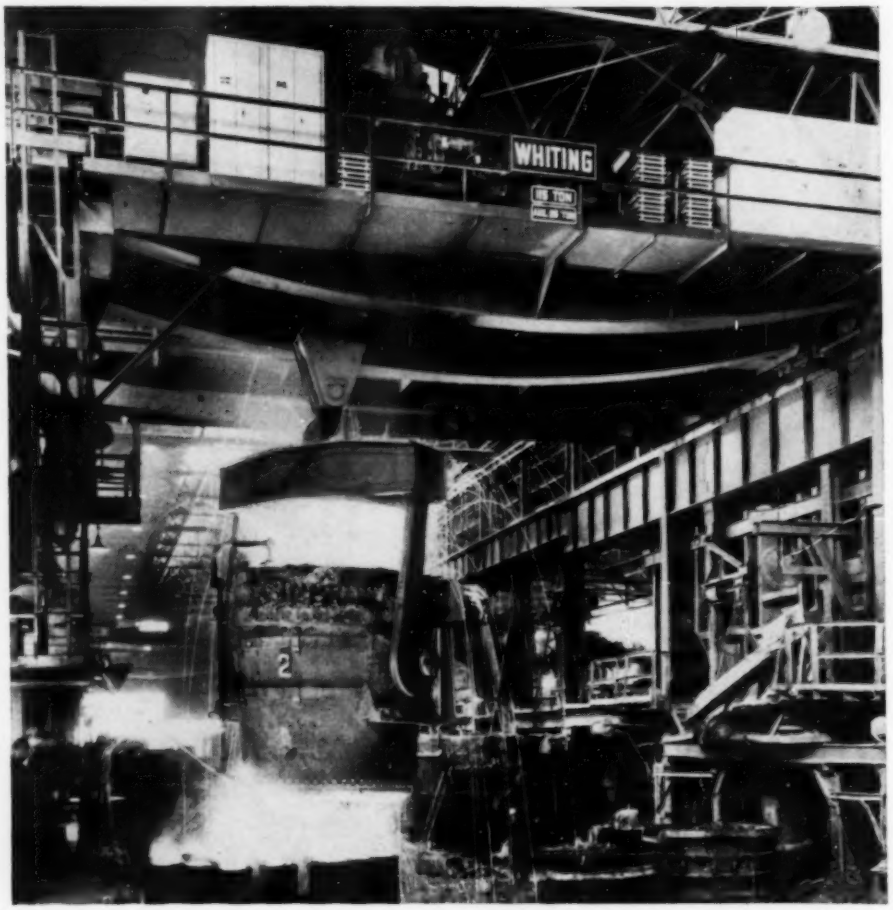
G-E Crane control is tailored to today's steel needs

A complete line of control for d-c crane applications makes it possible for General Electric to tailor systems exactly to steel mill requirements. G.E. has had over 50 years' experience in designing and manufacturing crane controls.

Minimum maintenance is required with General Electric crane control. Each component is tested under severe operating conditions and proved for the job before delivery.

Well integrated systems are assured you when one manufacturer co-ordinates the complete crane drive. General Electric engineers will help you get the most out of your crane installation by working with you or your crane manufacturer from initial design to final installation.

You can save thousands of dollars a year in materials handling costs because of the handling accuracy inherent in G-E controls. Write for Bulletin GEA-5408A (see coupon on right).



Lower maintenance, longer service with G-E Limit Switches

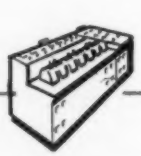
Heavy duty construction of General Electric rotating limit switches enables them to stand up under the rugged shock, vibration and dust conditions of steel mill operation.

Double-break contacts provide long life by providing two contact surfaces. Each contact is independently adjustable for opening or closing. Insulated parts are high-quality non-conductors. There are no shunts or drum-type segments to maintain.

Wide range of gear ratios and types of enclosure give G-E limit switches great versatility. General Electric has a complete line of heavy duty track-type and rotary limit switches. Write for Bulletin GEA-5994 (see coupon on right).

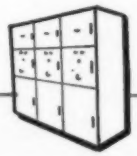
* Trade-mark of General Electric Company.

G-E control for the steel industry meets AISE standards and is designed for rugged operations in steel mills. From simple resistors to complex mill drive control, General Electric Company will supply all your steel mill needs.



SPECIAL STEEL MILL CONTROLS

SYNCHRONOUS MOTOR CONTROL



LIMITAMP CONTROL

News for the steel industry

G-E Master Switches designed for tough steel applications

Available with up to 12 circuits as standard equipment, G-E master switches are specifically designed for rugged applications. Cam-operated and dustproof, they are ideally suited for steel mill drives, crane hoists, and other tough materials handling operations.

Rugged, tight-fitting, cast aluminum covers help protect operating cams and contacts against dirt, dust and damage from external blows. A wide variety of operating mechanisms are available.

All sizes of G-E master switches are actuated by cam assemblies which can be modified easily to change operating sequence. Position feel is obtained by a star-wheel and pawl arrangement which is adjustable to operator's preferences.

It is easy to remove stationary and movable contacts in a minimum of time without disturbing the switch wiring. For more information on G-E master switches call your nearest General Electric Apparatus Sales office.

Simplified Installation—low maintenance with G-E drum switches

Installation and maintenance time on General Electric's full line of drum switches has been substantially reduced by designing all working parts to be completely accessible.

Conduit boxes are provided with knockouts in the bottom, back and sides so many connections can be made.

Easily removed front covers (back covers also on larger units) provide room for wiring and for adjustments.

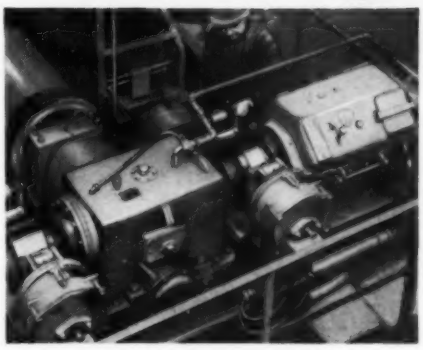
Doubled contact life is possible with G-E drum switches. Reversible finger contacts mean the elements need only be turned over when excessive wear is noted. Only one screw has to be removed to do this. Segments are easily replaceable and they can often be turned end for end to provide even longer life.

Operating mechanisms are interchangeable—standard horizontal handle for rope wheel, vertical handle, or switchboard mechanism. In addition, the mechanisms may be positioned in increments of 90° for maximum flexibility. Write for Bulletin GEA-6307.

New G-E DC Brake provides excellent service at Jones & Laughlin

Jones & Laughlin Steel Corporation, one of four leading steel companies that participated in field testing G.E.'s new d-c brake, specified several more brakes for a slab handling crane on the basis of the excellent performance of the test brake.

Typical initial installations included screwdowns, billet chipper, slab depiler, manipulator crane, and coil unloader. Over 600 subsequent installations have proved the brake's performance under severe operating conditions.



General Electric Company
Apparatus Sales Division
Sec. B784-1
Schenectady 5, New York.

Please send me the following bulletins:

- ☐ GEA-5408A. DC CRANE CONTROL
- ☐ GEA-5994. LIMIT SWITCHES
- ☐ GEA-6307. DRUM SWITCHES
- ☐ GEA-6214. DC BRAKES

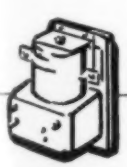
NAME.....

COMPANY.....

CITY.....STATE.....

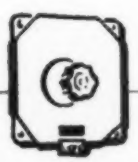
Progress Is Our Most Important Product

GENERAL ELECTRIC

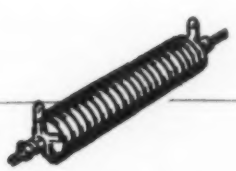


RELAYS

CONTACTORS



RHEOSTATS



RESISTORS

THRUSTOR® MECHANISMS

Bailey Cinder Notch Stopper

keeps workmen out of a danger zone

Stopper in "out" position.

Position after cinder notch has been closed.

Since the Bailey Stopper is controlled remotely, no workman need approach the cinder notch—assuring safe, dependable closing every time. Gravity action inserts the bott in the monkey, and an air or steam powered cylinder withdraws the stopper to the "out" position. Design is such that alignment is true at all times. For durability, both the bott and rod are water-cooled.

WILLIAM M. Bailey COMPANY

ENGINEERS

LEADERSHIP THROUGH QUALITY

1221 BANKSVILLE ROAD PITTSBURGH 16, PA

(*Continued from page 146*)

name of "Lectromelt Furnace" and of electric and gas dryers sold under the name of "Lectrodryers."

W. E. Kerr, vice-president of McGraw Electric Co., will be in general charge of the business which will be operated as a division of McGraw. The present heads of the various departments will continue in charge.

NEW PLANT LOCATION ANNOUNCED BY SELAS

▲Selas Corp. of America has moved from its Philadelphia site to a new plant in the suburbs just north of the city.

The new plant, in Dresher, Pa., has been developed to provide fully coordinated facilities for all of the company's activities. All research and development is now concentrated in one centrally located building specically designed for intensive study of heat and fluid processing. The only exception is the ceramics laboratory, which adjoins the ceramics production area in the manufacturing building, for convenience to the necessary kilns.

The manufacturing building, containing all production equipment as well as parts and raw-material storage, adjoins the laboratory. Curtain-type interior wall construction and special mounts for production machinery provide the flexibility to adapt this area to any future pattern of production requirements.

ANNOUNCES CHANGE OF COMPANY NAME

▲The name of Central Boiler & Mfg. Co. has been changed to McGregor-Michigan Corp.

Operating as Central Boiler, the firm has been in business since 1841, although it has not made boilers in many years. Constructions include many types of steel mill equipment, chemical and petroleum processing equipment, machine bases, diesel engine beds, heat exchangers, stacks and other mild and stainless steel plate fabrications. Steel warehousing service and power plant maintenance are also provided.

McGregor-Michigan Corp. has its main offices at 5818 Rivard St., Detroit 11, Mich., with additional fabrication and warehousing facilities in northeast section of Detroit.

For Roll Corrugating and Culvert forming . . . see

Stamco

Stamco 8 ga. Culvert Curving roll

Stamco 8 ga. x 36" corrugated shear

Stamco high duty Culvert Punch and Riveter equipped with air operated friction clutch

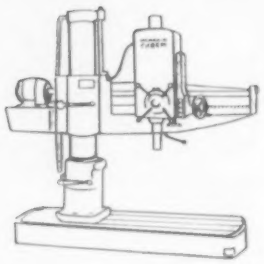
Stamco standard Culvert Punch and Riveter

STAMCO, Inc., New Bremen, Ohio

LET SIMMONS REBUILD AND MODERNIZE YOUR RADIAL DRILLS

Investigate the important production, maintenance and tax savings of SIMMONS ENGINEERED REBUILDING for your: Lathes, Planers, Surface Grinders, Cylindrical Grinders, Vertical Millers, Openside Planers, Automatics, Vertical Boring Mills, Turret Lathes and Radial Drills.

A qualified Simmons rebuilding engineer will discuss it with you. Write, wire or phone today.



You, too, can cut costs, increase and improve production with a Simmons Special machine tool

ANY metal-working job can be done more economically by a specially engineered machine tool. For 45 years, Simmons has designed and built Special machines for many of America's "blue chip" companies.

Ask us to show you how a Simmons Special can do any particular production job for you more efficiently, faster, and at lower cost. Call or write and describe your own machining problem. Address ENGINEERING DEPARTMENT.

Send for your copy of THE SIMMONS WAY

Illustrated case histories of recent rebuilding, modernization, and conversions by Simmons, and descriptions of Simmons special-purpose machine tools.

Check these machines now available from stock

LATHES

30″x48′ Niles "Timesaver" Boring Lathe
42″x11′ cc Niles Geared Head Engine, 230 V, DC
54″x23′ cc N.B.P. Q.C.G. 230 V, DC
14′x35′ cc Niles Geared Head Engine
50″ Sellers Wheel, Late Type, Herringbone Gear Train
1-H Libby Turret, Chucking
3-R Gisholt Turret, Long Bed
4-R Gisholt, 9¼″ Hole
32″x12′ cc Niles Forge Turning

BORING MACHINES

78″ Betts Fixed Rail, Late, Vertical
100″ N.B.P. Heavy 230 V, DC
10′ Cincinnati Extra Height, Vert.
No. 4 LeBlond, Gun Boring, 36′ Bed
No. 420 Barnes, 2-Spindle Deep Hole

GRINDERS

6″x18″ Cincinnati "ER" Plain
16″x36″ Norton "C" Hydraulic

7′ Arm 19″ Column Carlton Radial
No. 5 Cincinnati H.P. Miller, 1940
No. 2 Pratt & Whitney Jig Borer
32″ Ohio Heavy Duty Shaper
25″ Jones Crank Slotter
16′x12′x40′ N.B.P. Planer, 4 Hds.

SIMMONS ENGINEERED Rebuilding
GIVES MACHINE TOOLS A NEW LEASE ON LIFE

Since 1910 . . . Builders and rebuilders of unconditionally guaranteed machine tools

Simmons Machine Tool Corporation
1712 North Broadway, Albany 1, N.Y.
New York Office: 50 East 42nd Street, New York 17, N.Y.

SQUARE D ANNOUNCES EXPANSION PROGRAM

▲ Allocation of $9,000,000 for new plants and other capital improvements to be completed during the next 22 months has been announced by Square D Co. The amount equals the company's total investment in new plants during the first 10 post war years, which doubled manufacturing capacity.

Square D, which does not issue 1955 figures until March, had sales of "over $80,000,000" for the period, including those of the Electric Controller and Manufacturing Co., acquired late last year in a merger. Gordon Peterson, president, said Square D had sales of $56,000,000 in 1954, and Electric Controller had sales of $9,000,000 for the same period.

"The expansion program, to be financed from company funds and including a $3,000,000 Milwaukee plant previously announced, will provide Square D with an additional 400,000 sq ft of high production facilities," Mr. Peterson said, "making it possible to substantially increase output of present lines as well as to launch several new product developments."

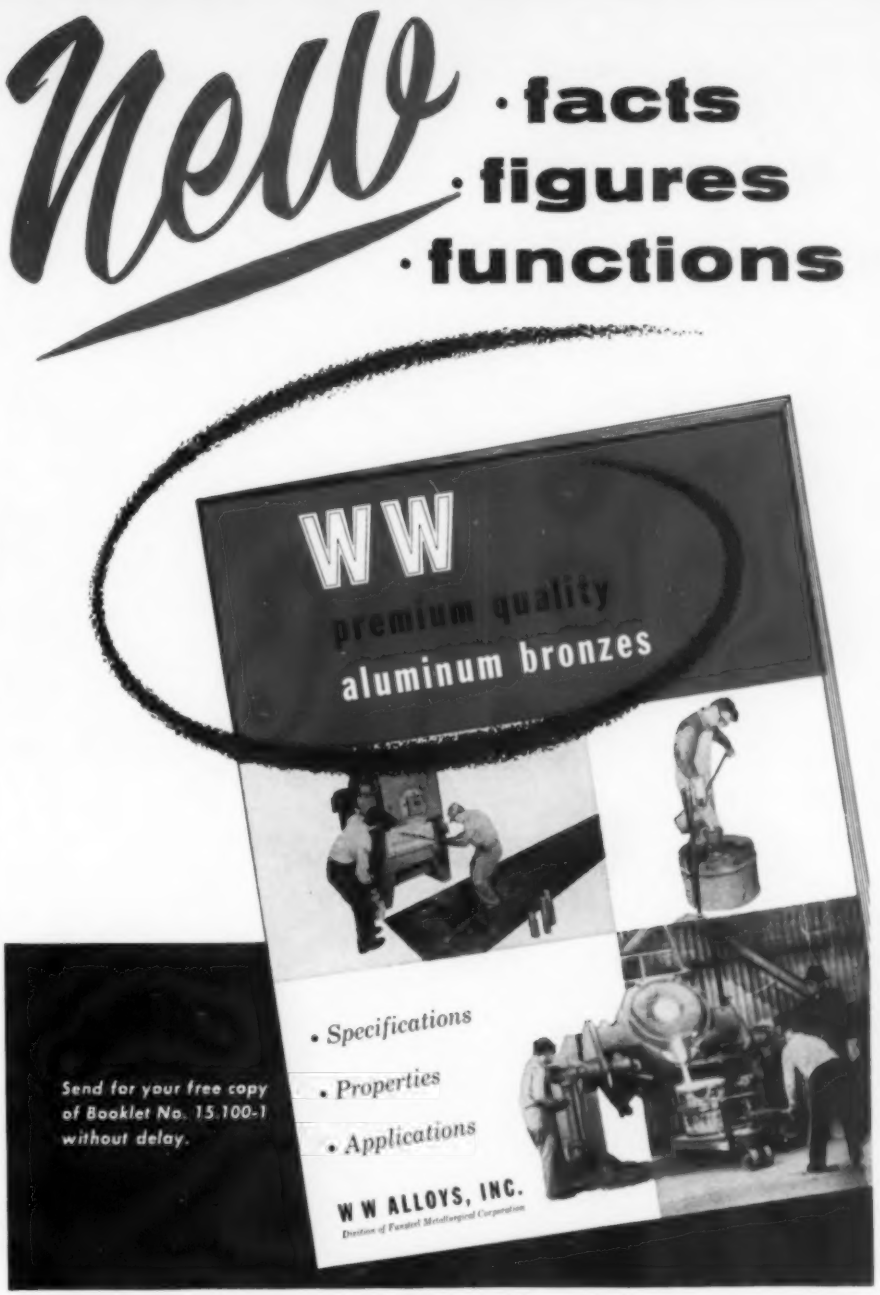
JOY LAUNCHES NEW DIVISION AT BUFFALO

▲ Establishment of a Turbo-Dynamics Division at Buffalo, N. Y., has been announced by Joy Manufacturing Co.

Company officials stated that the objective is the formation of a major new division producing advanced compressors, turbines, and other air and gas-handling devices. The new research and testing facility will be aimed toward laboratory development of prototypes and will establish designs for regular manufacture.

Meetings

▲ The one hundred years' anniversary of the Association of German Engineers (Vereins Deutscher Ingenieure) (VDI) is scheduled from the 12th to the 15th of May, 1956 in Berlin, Germany. A series of interesting papers of interest to many engineers are scheduled for presentation during this period. Foreign engineers are invited to attend.



It's hot off the press and packed with facts about the properties, composition and functions of WW Aluminum Bronzes. Steel men will be particularly interested in the description of aluminum bronze alloys used for heavy duty applications such as universal joint slippers (also available "cast-to-size"), guides and wear plates, screw boxes, breaker blocks, gears, worms, and worm wheels, table bearings, traverse nuts, manipulator link bushings, hydraulic valve parts, liners, welder dies, wedges, and many more.
You'll find a complete 17-page section of engineering data describing each grade, a Specification Index Chart for comparison, six pages of machining recommendations and tool geometry. Also included is information on our engineering and metallurgical consultation services, foundry and machine shop facilities.

WW ALLOYS INC.
11644 CLOVERDALE AVE.
DETROIT 4, MICHIGAN
Division of Fansteel Metallurgical Corporation

80 YEARS of Lubrication Service to Industry

Brooks lubrication engineering—constant research in the laboratory and "on the job" has been devoted exclusively to the development of industrial lubricants. The wealth of experience and knowledge gained through solving the "tough" lubrication jobs of industry during the past eighty years has resulted in a dependable extreme pressure lead base compound known throughout industry as "Leadolene Klingfast." Hundreds of case studies prove that it lowers lubrication costs and increases service life of equipment. We suggest you try it for trouble-free, economical lubrication of the following:

OPEN GEARS • SCREW DOWNS
MILL TABLES • WIRE ROPE • MILL PINIONS
HIGH TEMPERATURE LUBRICATION
HYDRAULIC SYSTEMS • CIRCULATING OIL SYSTEMS • FLEXIBLE COUPLINGS
WORM DRIVES • ROLLER BEARINGS
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Write for your copy of "The Brooks Oil Story!"

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Characteristics of LEADOLENE KLINGFAST

pH-ilm Strength . . . 50,000 psi minimum.

Adhesiveness . . . Affinity for metal develops maximum adhesion providing permanent coating on gears.

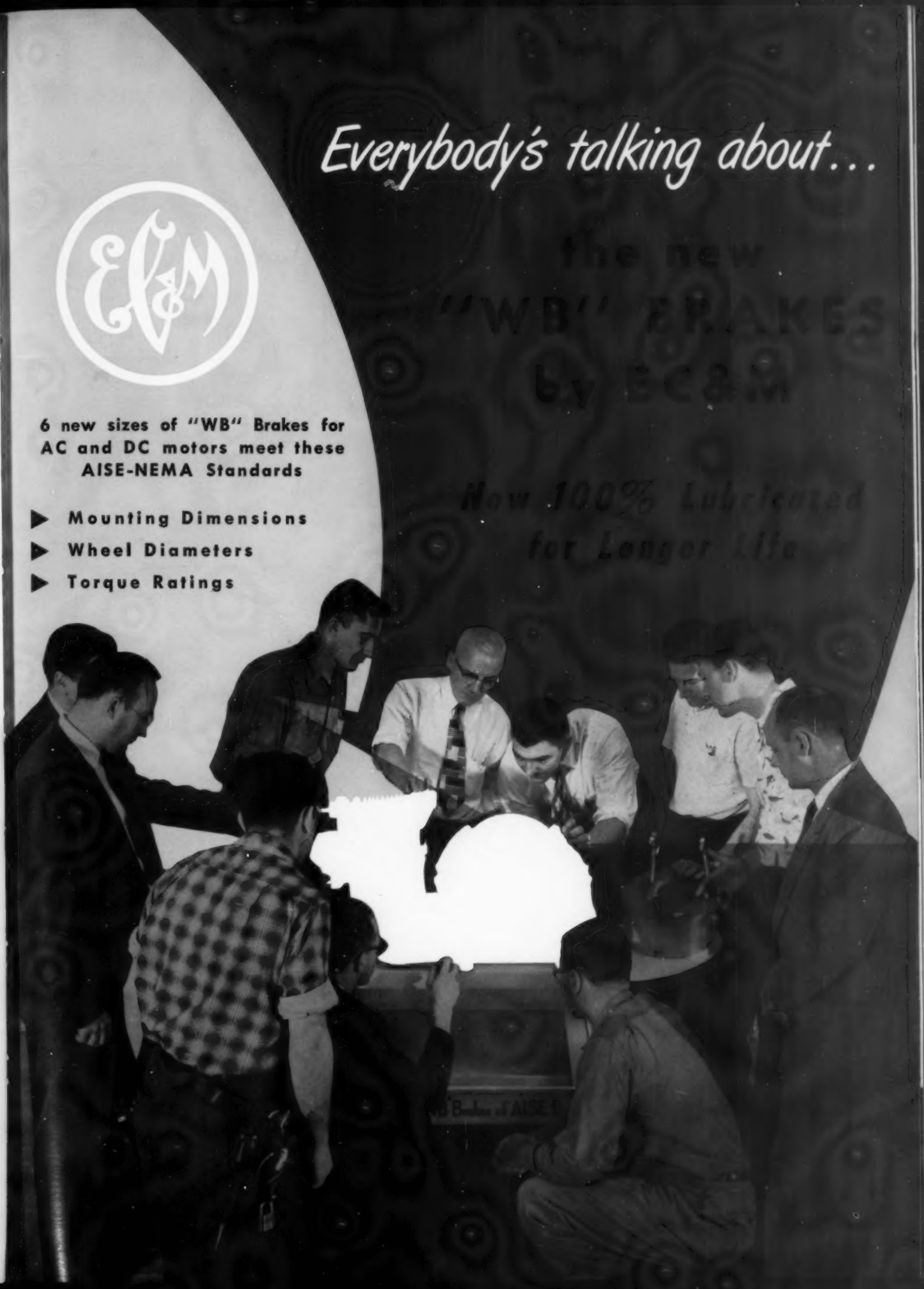
Water Repellence . . . Effectiveness is not reduced by water.

Corrosion Prevention . . . Never acidic and will not etch or corrode.

Compounded Stability . . . Will not bleed or change physical condition within a greater temperature range.

Low Temperature Factors . . . Does not harden, crack or decrease in adhesion.

Abrasive Resistance . . . Repellent to adhesion of scale, metallics and other contamination.


Everybody's talking about...
E&M
6 new sizes of "WB" Brakes for AC and DC motors meet these AISE-NEMA Standards
▶ Mounting Dimensions
▶ Wheel Diameters
▶ Torque Ratings

these improvements m

EASIER TO MAINTAIN.

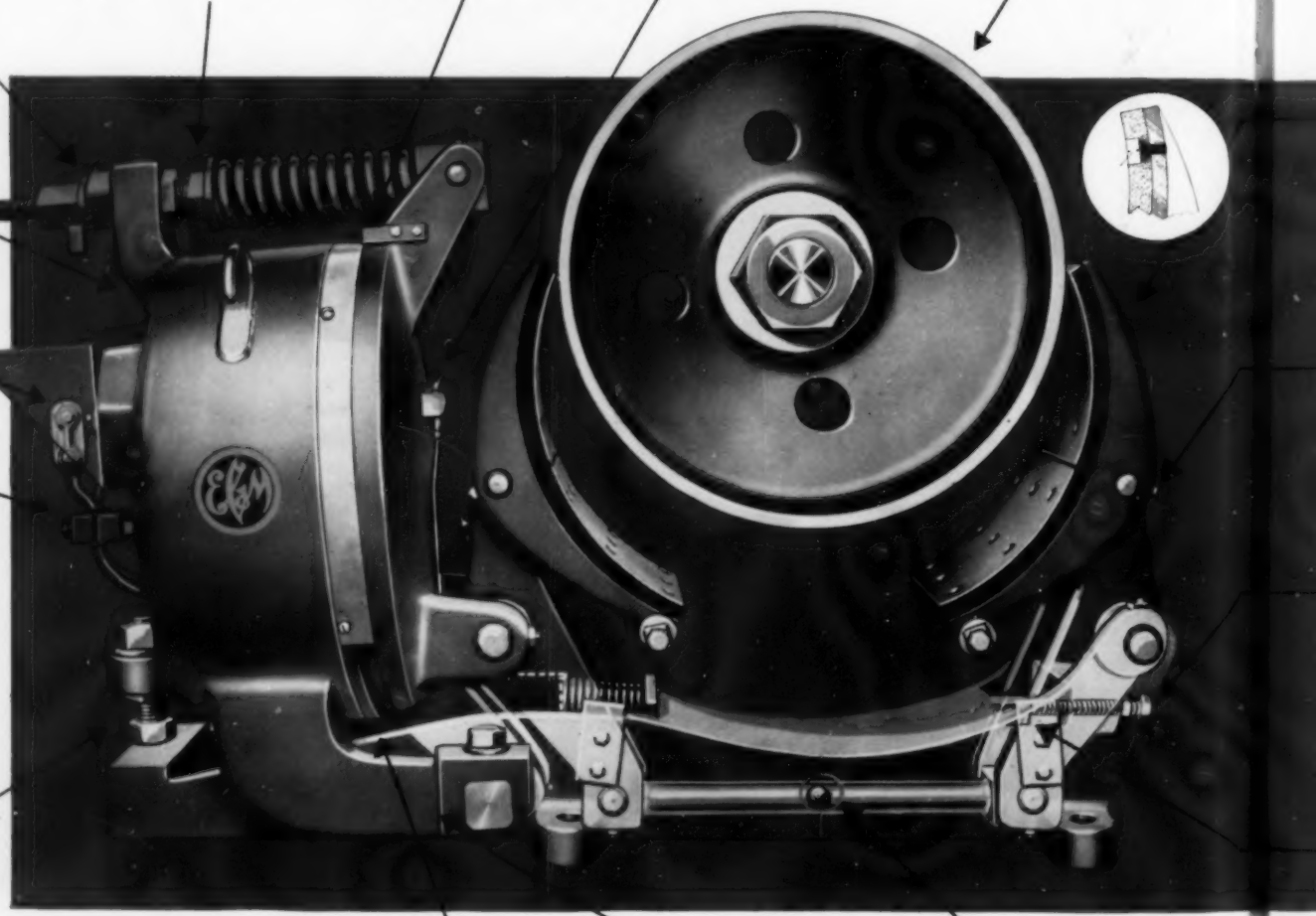
Manual release is standard on all sizes of these AISE-NEMA WB Brakes.

Bronze adjusting-nut on torque-spring rod has fine pitch threads for easier and closer adjustment.

Armature air-gap indicator shows visually when adjustment is needed to compensate for brake-lining wear.

100% - lubricated forces dirt out, all bearings alemite-lubricated.

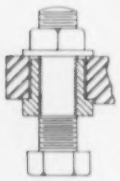
ECAMITE wheels are furnished as standard on all "WB" Brakes.



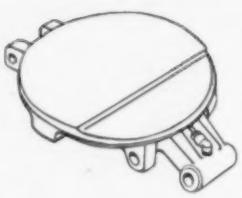
Magnet-case remains stationary and contains unit, armored coil.

Coil leads with solderless connectors under protective shield. Conduit connection box is optional.

Cable clamps for customer's incoming leads.



Single adjustment for brake lining wear. Adjusting-nut screws into stainless steel threaded bushing in magnet-case. This gives longer threaded path for greater bearing surface — easier adjustment — only single wrench required. Nut on top locks against machined surface.



Armature-face recessed at bottom allows dust to fall free — prevents clogging.

Magnet-case removable as a unit without disturbing remainder of brake.

Connecting lever remains below the brake wheel and is of tubular construction. Alemite fitting (on both sides) permits greasing four bearings from this one fitting.

ARMORED COIL CONSTRUCTION

WB Brake coils . . . protected by a steel enclosure, permit quick coil removal. After vacuum-impregnating with No. 371 polymerizing varnish and baking, coil is sealed in its protective enclosure with No. 372 Epoxy compound. This compound does not soften, but holds the coil securely against movement.

s make the new "WB" brakes

N. . . LONGER LASTING!

Molded brake blocks, riveted securely in place, are made from an improved material having a higher coefficient of friction. Permissible wear is ⅛" on the smallest size to 7/16" on the largest size.

Fixed bearing-pins locked with stainless steel setscrews reduce number of lubrication points.

This adjustment equalizes clearance of both shoes.

Hardened steel camrails retain clearance between shoes and wheel with brake released.

These new EC&M "WB" Brakes are built to AISE-NEMA standards. The basic principles which made "WB" Brakes the outstanding brake for heavy mill service have not been changed. The new design includes several improvements making EC&M "WB" Brakes even longer lasting and easier to maintain. These improvements are:

1 — 100% lubrication . . . for longer life, for freedom of operation by forcing dirt out of bearing surfaces.

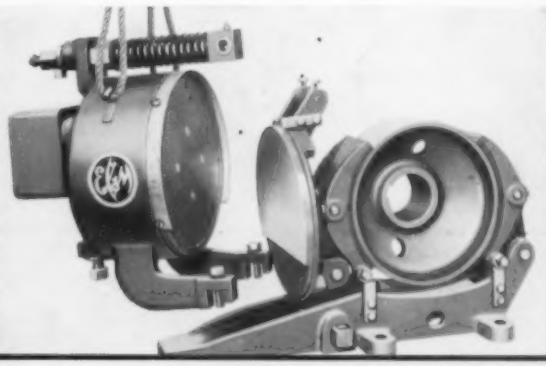
2 — Recessed armature . . . eliminating pocket for dust collection.

3 — Single wrench adjustment for brake-block wear . . . restores air-gap to normal, adjusting-nut has fine pitched threads.

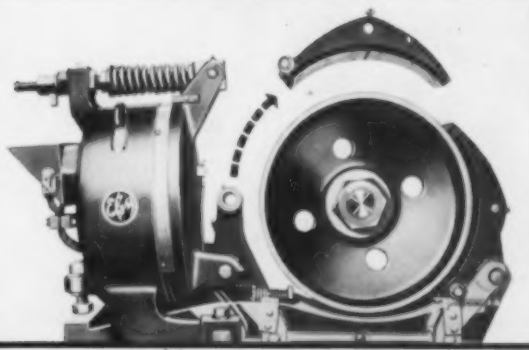
Remaining unchanged because of their proven acceptance and time-saving advantages are these features:-nothing over the brake wheel, manual release, single adjustment for lining wear, stationary magnet and sturdy 2-shoe construction.

These new EC&M "WB" Brakes are available with series and shunt coils for d-c service, and are supplied for rectifier-operation on a-c circuits. For LONG-LIFE Brakes, specify "WB" Brakes by EC&M.

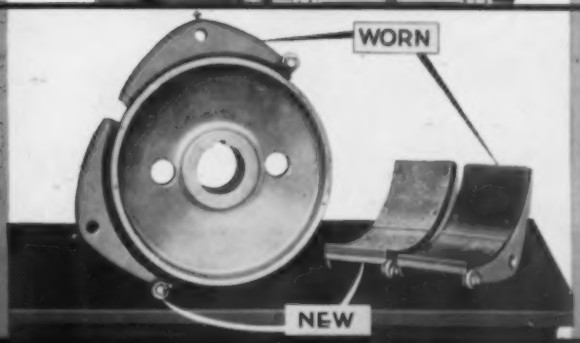
SIMPLIFIED MAGNET REMOVAL
Maintenance men appreciate the time-saving construction that makes coil changing a simple procedure. The magnet case can be swung away without disturbing the remainder of the brake. A coil can be replaced quickly or a complete new magnet installed in a matter of minutes.

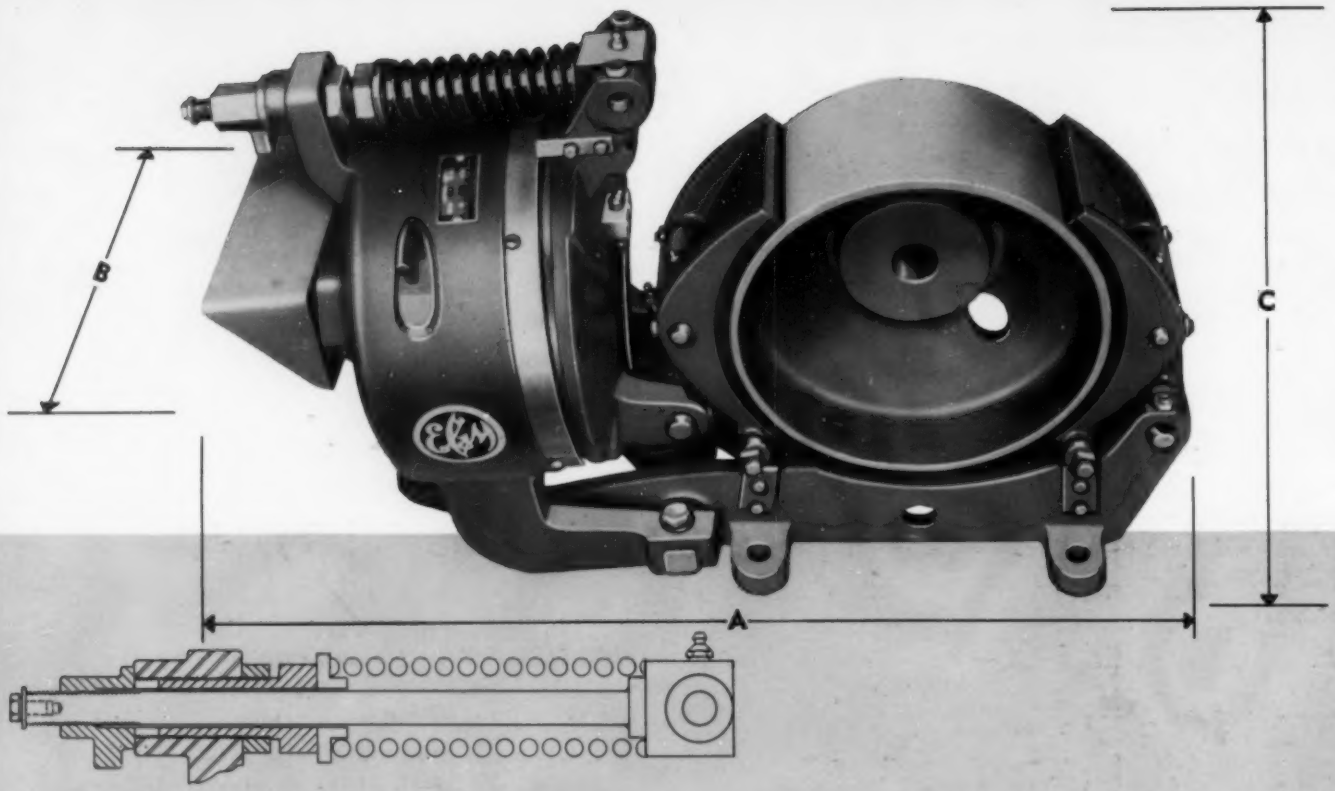


SHOES AND LINERS EASILY REMOVED
With shoe bearing-pins slipped out, shoes slide up on top of the wheel easily to permit worn brake-linings to be replaced. This has been standard construction with "WB" Brakes for years.



ACCURATELY FORMED RENEWABLE BRAKE BLOCKS
WB Brake Blocks retain their frictional quality longer than any other braking material. They are accurately formed so that new blocks fit the arc of the wheel and shoe surface as accurately as the original block.

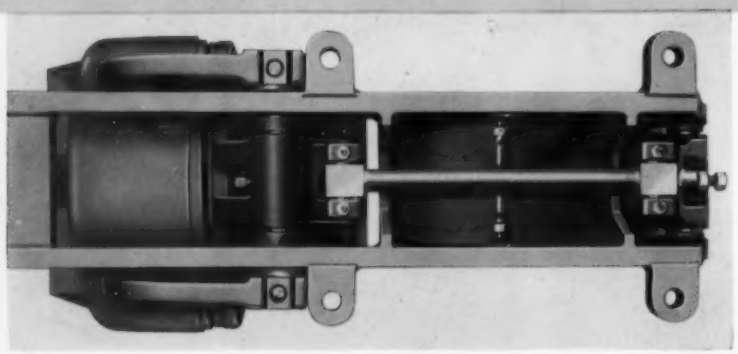




NEW OPERATING SPRING CONSTRUCTION

Operating spring force transmitted directly to magnet armature. Guide rod, threaded only at outer end under manual release (bronze) nut, is under tension only when brake is manually released. Brake torque is adjustable by a bronze nut threaded into the magnet-lug. Fine pitch threads permit closer and easier torque-adjustment. A jam-nut locks the setting.

Brake Size (Wheel Diameter)	600-Series Motor size	BRAKE TORQUE RATINGS in Lbs. Ft.				Approximate Outline Dimensions in Inches		
		Series-Wound Brakes		Shunt-Wound Brakes				
		½ hour Rating	1-hour Rating	1-hour Rating	Continuous Rating	Length "A"	Width "B"	Height "C"
8" WB	402 602	100	65	100	75	24¼	9¼	13½
10" WB	603 604	200	130	200	150	27¼	10¾	16⅜
13" WB	606 608	550	365	550	400	34¾	13¼	20⅛
16" WB	610	1000	650	1000	750	38⅝	15½	22¾
19" WB	612 614	2000	1300	2000	1500	45¾	18½	26½
23" WB	616 618	4000	2600	4000	3000	55⅜	21⅞	31⅝



Bottom view of new "WB" Brake showing tubular connecting lever for lubricating bearings at both ends from one alemite-fitting. The brake can be mounted either right or left hand, and the lubrication may be applied from either side through an opening in the brake frame.

EC&M "WB" Brakes have long been known for their fast response in releasing and setting. The fundamental short-stroke characteristic of these new "WB" Brakes which gives quick action has been proved on crane-hoists and hard-worked mill applications. Unit pressure between brake shoe and wheel remains at substantially the same low value as in the previous WB Brakes. These new EC&M "WB" Brakes, built to the AISE-NEMA Standards, are designed to give smoother operation . . . safer stops . . . and less maintenance. Specify EC&M Bulletin 1000 Type WB Brakes.

THE ELECTRIC CONTROLLER & MFG. CO.

A Division of the Square D Company

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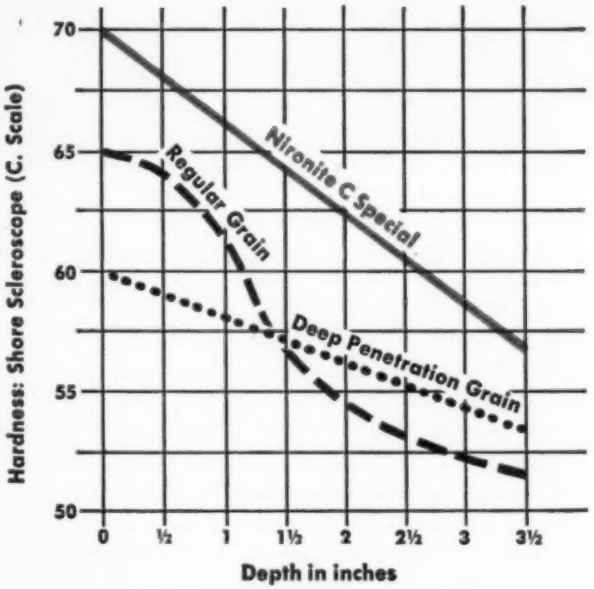
TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

How to pick rolls for bar and billet mills

The crux of the problem—Roughing a pass in a roll for a bar mill.



Generalized curves show how hardness decreases below the surface of three types of roll.

Like all rolls, those for the intermediate and finishing stands of bar and billet mills must possess the best possible balance of strength-vs.-hardness. However, they cannot be chosen on this basis alone.

The problem is complicated by the shape and depth of the passes. Many rolls must be cast plain because of the size of the passes or because of the roll user's need for plain rolls which may be turned for any section. Hence, large amounts of metal must be removed during turning.

As a result the metallurgist strives for two prime objectives in rolls for these applications. They are (1) the greatest possible depth of hardness and (2) fine grain structure to provide smoothness of work surface at the bottom of the passes.

A practical solution—The Nironite C Special roll is the answer that Mack-Hemp has developed to meet this problem. In this indefinite chill nickel-chromium alloy iron roll, depth of penetration is achieved by careful control of the carbon content. This results in deep penetration as well as less and finer graphite in the solidified iron. Hardness decreases very gradually as distance from the surface increases (see graph at left). Thus, this manipulation of carbon provides excellent wear resistance even at the bottom of deep passes. And the low graphite content which is assured by this special composition provides excellent surface condition at depths well below the original surface.

Nironite C Special rolls are only one example of the way Mack-Hemp can combine metallurgical research with nearly five generations' experience in the "art" of roll making to improve the performance of modern rolling mills. For help with your special rolling problem, write us today.

MACKINTOSH-HEMPHILL

You get more tonnage from the rolls with the Striped Red Wabblers

DIVISION OF **E. W. BLISS COMPANY**

* ANY TYPE
* ANY SIZE
* ANY BRAND
* IMMEDIATE DELIVERY
* DAY OR NIGHT

"You can catch more flies with honey than you can with vinegar"--is an old, familiar truism that was popular back in grandpa's day. And, it is just as true in this jet-propelled atomic age of today as it ever was in those by-gone, horse-and-buggy days when it was first written.

From the beginning it has been the policy of this company to be genuinely friendly with everybody--customers and suppliers alike. It's a policy that has won this company a host of good friends--and helped keep them, year after year.

For bearings--any type, any size, any brand--dial the number below. You'll get *immediate* delivery, day or night. Not only that but--you will get the kind of friendly service that will make YOU smile with pleasure, too. Try it!

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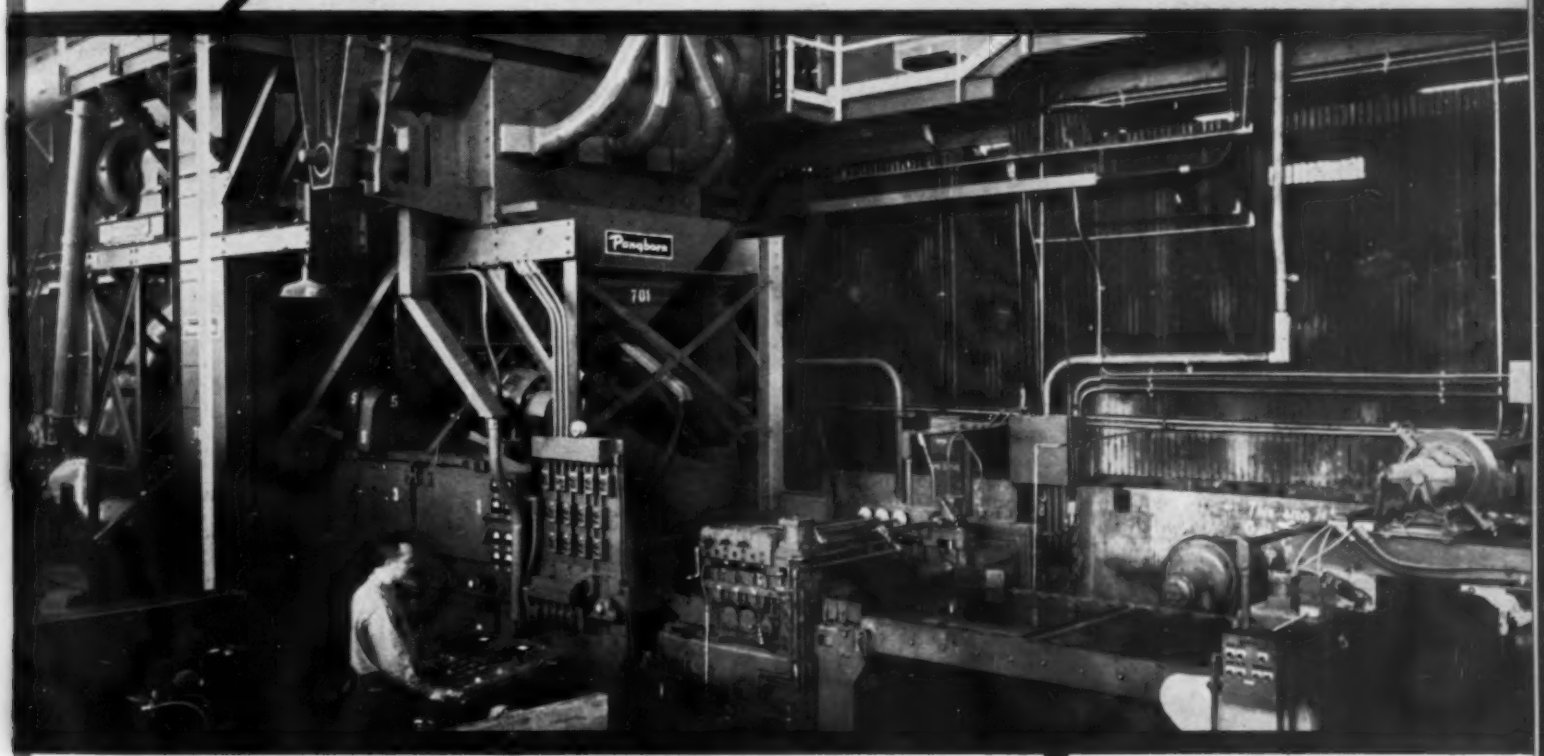
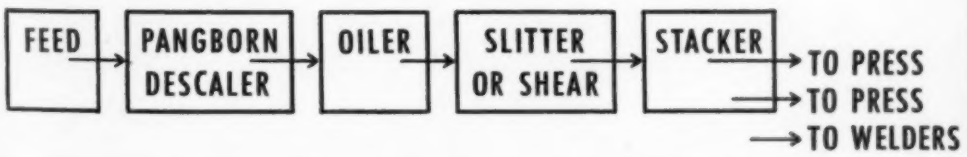
STEEL FABRICATORS!

NOW Pangborn offers you

Automation!



For fabricators using flat steel, coils, cut lengths—Pangborn Rotoblast® Descaling Machines offer *straight line* operation. One feed through descaler, oiler, slitter and stacker!



Here's How You Benefit!

- *You cut costs by using hot rolled unpickled steel.*
- *You speed production.*
- *You reduce labor costs.*
- *You eliminate problem of acid fumes and acid disposal.*
- *You use minimum floor space.*

For full details on automation for fabricators, write for Bulletin Number 224 to Pangborn Corporation, 4400 Pangborn Blvd., Hagerstown, Maryland.

Manufacturers of Blast Cleaning and Dust Control Equipment.

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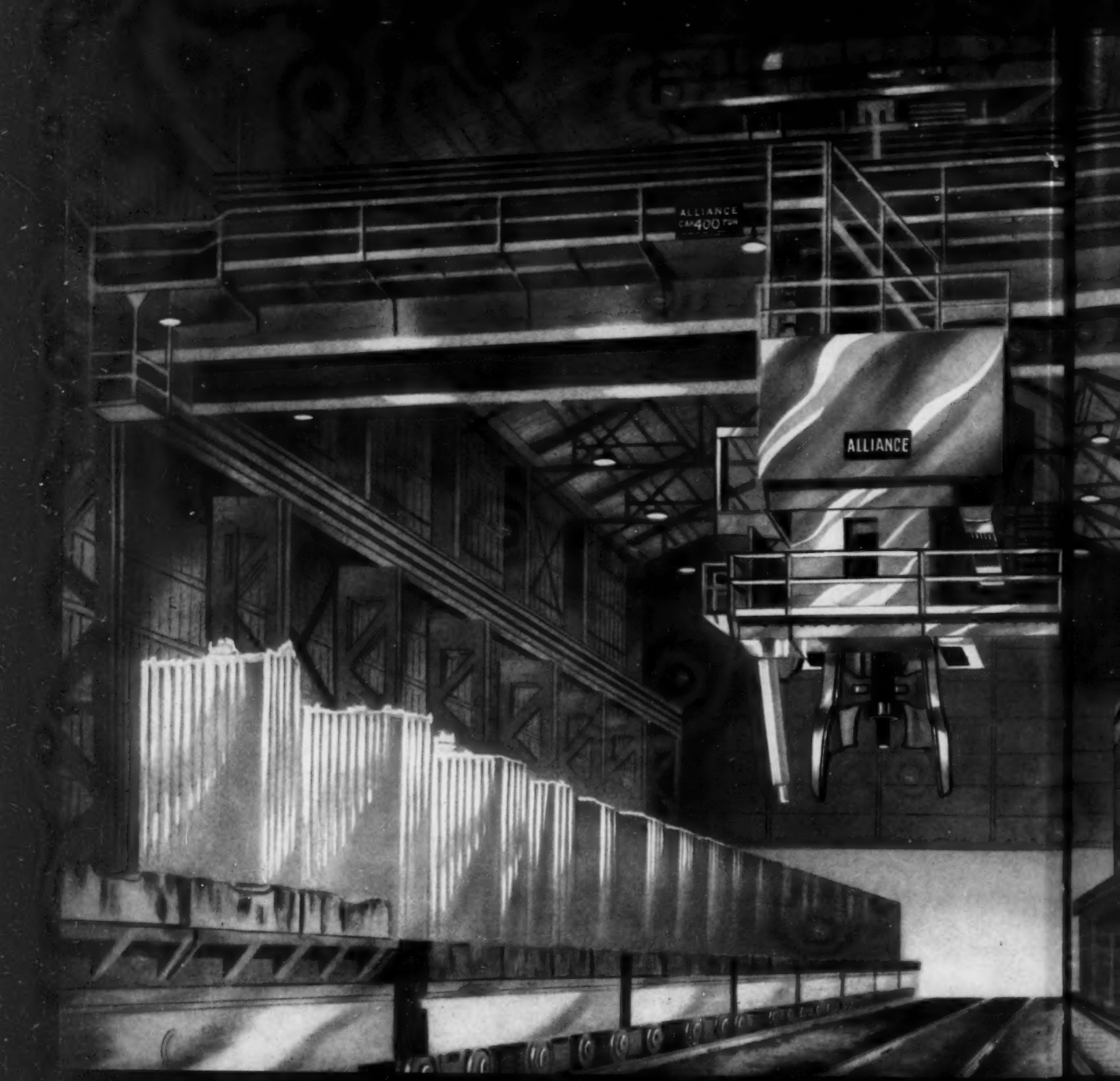

THE WORLD'S LARGEST STRIPPER CRANE

• This 400-ton Alliance push-pull Stripper Crane is the world's largest. It can exert 2,400,000 pounds' pressure to strip moulds from ingots — cleanly and safely. The patented Impact Stool Loosener speeds up the stripping operation. The stripping mechanization has a nominal rating of 400 tons but is designed to stand forces of 1200 tons. Its many exclusive design features are a result of Alliance's knowledge of mill problems and requirements. They design the world's biggest cranes, manipulators and special machinery. Their experience assures you the best in modern design. A letter, wire or phone call will put your problems into the hands of The World's Largest Builders of the World's Largest Cranes.

THE ALLIANCE MACHINE COMPANY •

EXCLUSIVE with ALLIANCE

The Alliance Impact Stool Loosener makes your stripper crane more useful, more efficient and saves wear and tear on the crane and ingot buggies. The Impact Stool Loosener can be installed on most stripper cranes now in your service.

Alliance

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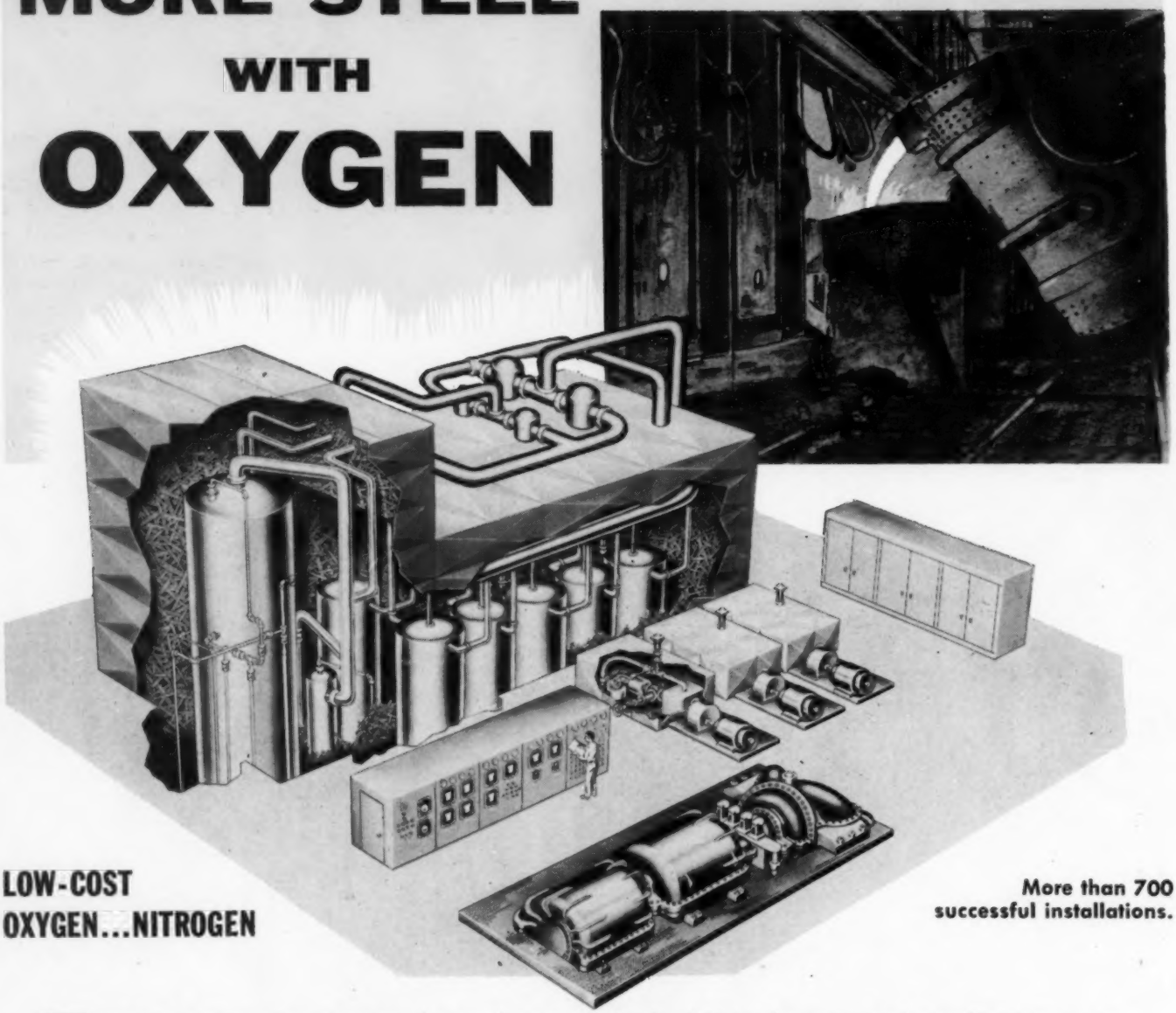
MORE STEEL WITH OXYGEN



LOW-COST OXYGEN...NITROGEN

More than 700 successful installations.

Low cost oxygen can solve your increased steel tonnage production problems.

The contrast between the extremely high capital investment needed for expansion of steel producing facilities and the remarkably low cost of oxygen available from Air Products generators has been the determining factor in the decision by many steel manufacturers to use oxygen in blast furnaces, open hearths, and steel converters for increased tonnage.

Air Products will install, *on a lease basis without capital investment by you,* an oxygen generating station specifically designed for your particular requirements.

We design and manufacture:

Large Capacity Tonnage Generators for unlimited quantities of oxygen and nitrogen regardless of size, purity or cycle

and

"Packaged" High-Purity Generators, producing high purity oxygen and nitrogen separately or simultaneously.

Let us help you investigate the possibilities of increasing your tonnage and save money with oxygen.

Air Products INCORPORATED **Dept. P, Box 538, Allentown, Pa.**

Personnel News...

Julius H. Strassburger has been appointed assistant vice president-engineering of National Steel Corp. Mr. Strassburger became associated with National Steel in 1924 as a combustion engineer for Weirton Steel Co., and remained in this capacity until 1941 when he became manager of the service and maintenance department. In 1951, he advanced to the post of assistant general superintendent and in 1953 was again promoted to assistant vice president-engineering of the Weirton Steel Co.

C. D. King has been appointed assistant to executive vice president—operations of United States Steel Corp. Previous to his appointment Mr. King was general chairman of the corporation's operating committees concerned with the development of advanced operating procedures. With Mr. King's appointment the operating committees have been reorganized with a separate chairman for each major process on a corporation basis. To accomplish this **J. J. Golden** has been made chairman of the U. S. Steel operating committee for steel production, **Alex Montgomery, Jr.,** chairman for rolling, and **J. M. Stapleton,** chairman for iron production. In addition, they will continue in their present capacities as assistants to vice president—operations—steel. Mr. King joined U. S. Steel in 1914 as a metallurgist at the Clairton Works of Carnegie Steel Co. After serving in various capacities at that plant he was made assistant to chairman, open hearth committee, U. S. Steel Corp. In 1930, he became chairman of the open hearth committee, and since that time has been made chairman of the Bessemer, blast furnace, coke, and rolling mill committees. He became assistant vice president—engineering in 1952 and assistant vice president—operations in 1953.

Ludrick Kukulinski was appointed superintendent of the mechanical department of Republic Steel Corp.'s Youngstown District steel plant. Mr. Kukulinski, a mechanical engineer since he joined Republic in Cleveland early last year, was formerly an erecting engineer for Koppers Co., Inc.

Philip Finale has been appointed chief engineer, rolling mill division of Engineering Supervision Co., a Birdsboro Steel Foundry and Machine Co. subsidiary. Mr. Finale was formerly chief engineer, Loewy-Hydropress rolling mill division, and was previously with Mesta Machine Co., where he was department engineer.

Louis H. Derrer, general manager — Steel Works Algoma Steel Corp. since 1946, has been appointed a vice president. Mr. Derrer has been with Algoma for 21 years in various managerial capacities. **Reg Armstrong,** who has been with the company for 33 years, has been promoted to assistant general manager — Steel Works. **Douglas Joyce,** formerly superintendent of blast furnaces and lately assistant to the executive vice president, has been appointed general superintendent. **C. C. Benton** was appointed assistant to the executive vice president. Mr. Benton, who will continue to direct open hearth operations, was formerly associated with Tennessee Coal and Iron Division, U.S. Steel Corp. **W. P. Dowhaniuk** succeeds Mr. Joyce as superintendent of blast furnaces. **B. W. H. Marsden,** has been appointed assistant superintendent, blast furnaces.

Clarence B. Randall will retire as chairman of the board of Inland Steel Co. on April 1, under the company's regular retirement policy. His vacated post will not be filled, and the responsibilities of chief executive officer which have been carried by the board chairman will be transferred to the president, **Joseph L. Block. Edward L. Ryerson,** former board chairman and now chairman of the executive committee, will also retire from that post at the time of the annual meeting in April. Two new officer posts have been created by the directors. **P. D. Block, Jr.** was elected as senior vice president, in which capacity he will be the second ranking officer of the company and will assume the duties of the president in the latter's absence. **Neele E. Stearns** was elected assistant to the president.

Paul Brand has been appointed assistant superintendent, Production Departments, Steelcrete Factory, Wheeling Steel Corp. He was formerly superintendent of the Electrical and Maintenance Department. **Raymond Lawson** was named superintendent of the Electrical Department. Mr. Lawson was previously assistant superintendent of the Electrical and Mainte-

JULIUS H. STRASSBURGER C. D. KING LUDRICK KUKULINSKI PHILIP FINALE

GEORGE PERRAULT, JR.

ELMER L. CASEY

W. E. PARFITT

M. N. ORNITZ

nance Department. Also, **Richard Glaser,** has been appointed assistant development engineer, Products Research Department at Steelcrete.

George Perrault, Jr., manager of the Salem, Ohio Rolling Mill Division of E. W. Bliss Co. was appointed a vice president of the company. Mr. Perrault joined Bliss as sales manager of the Rolling Mill Division in July, 1949. He was appointed manager of the Division in November, 1954. From 1940 until he joined Bliss in 1949, Mr. Perrault was associated with Salem Engineering Co. as an erection engineer and later as sales manager.

Elmer L. Casey was named executive vice president of M. H. Treadwell Co., Inc. Mr. Casey has been with the Seamless Tube Division of Babcock & Wilcox Co. and also the Boiler Division, and was vice president in charge of manufacture of E. W. Bliss Co.

W. E. Parfitt and **M. N. Ornitz** have been named divisional managers of Blaw-Knox Co., and **N. B. Ornitz** has retired. Mr. N. B. Ornitz joined the company in 1929 when Blaw-Knox acquired what is now the National Alloy Division. For many years he has been in charge of this division and the Power Piping and Sprinkler Division, in addition to serving as a vice president.

Edward R. Eggleston has been appointed chairman of the coke oven committee of Republic Steel Corp. Mr. Eggleston had been superintendent of the coke plant at the Youngstown District of Republic, a position he held for the past eight years. **Francis H. Armbrust,** who has been general coke oven foreman at Youngstown since 1948, has succeeded him as superintendent of the Youngstown coke plant.

George W. Kropp has been appointed superintendent of the Niles strip tin division of the Warren District, Republic Steel Corp. Prior to taking over his new duties, he had been general foreman of the rolling division since 1946.

Leonard S. Ham has been promoted to superintendent of the hot strip department of Granite City Steel. Co. He succeeds **Clarence R. Mitchell,** who was recently promoted to divisional superintendent in charge of all the company's rolling mills. At the same time, **Bert D. Houston** succeeds Mr. Ham as assistant superintendent of the hot strip department. He had been general foreman in the hot strip department.

Paul R. Morrow has been promoted to the position of assistant superintendent in the Steel Producing Division of U. S. Steel Corp's. Fairless Works, and **Joseph H. Swift** has been named assistant superintendent of the Coke and Chemical Works.

Hal D. Roach has been appointed Chicago sales representative for Laclede-Christy Co. Division, H. K. Porter Co., Inc.

Elmer C. Juhnke has been elected to the board of directors of the Osborn Engineering Co. Mr. Juhnke

ELMER C. JUHNKE

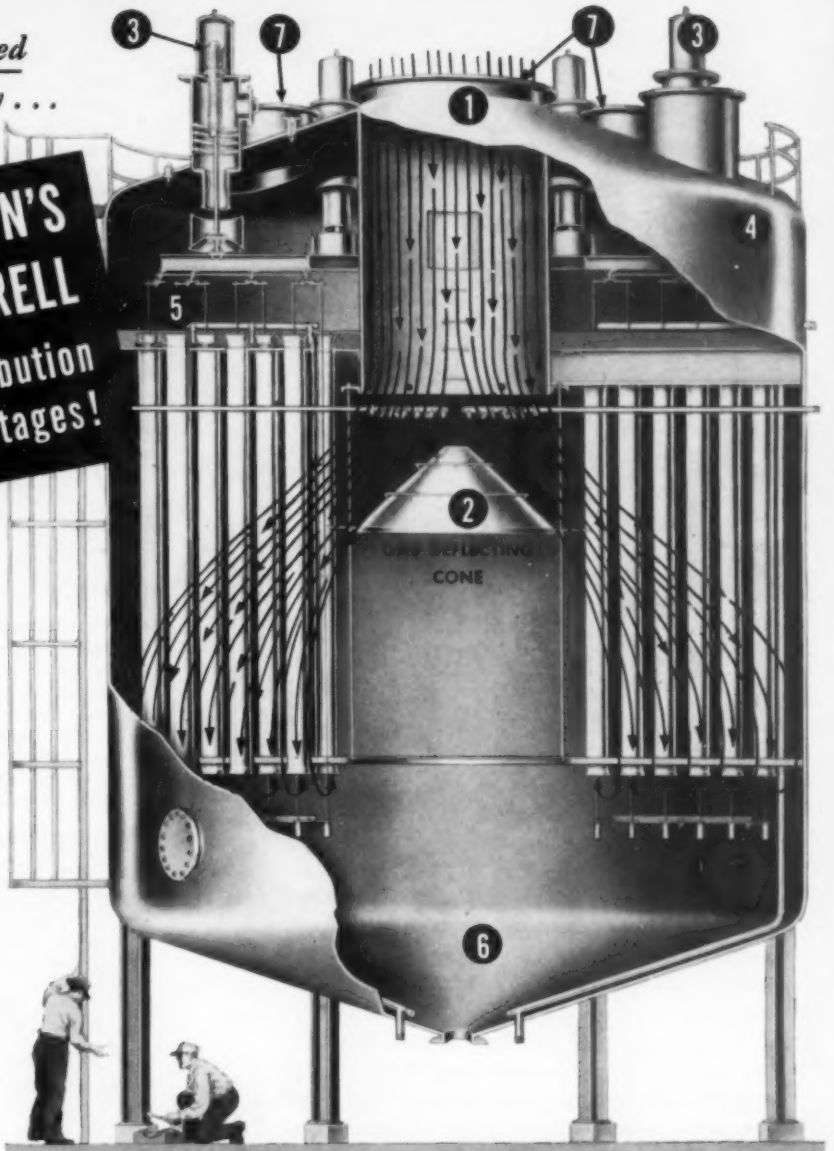
was formerly electrical engineer for Jones and Laughlin Steel Corp., and has been associated with Osborn as chief electrical engineer.

R. B. Heppenstall has been named president of the newly formed Midvale-Heppenstall Co. In addition, **J. P. Roche** was named vice president, **H. W. Davidson,** vice president and assistant to the president, **L. R. Loewen,** secretary and treasurer, **A. O. Schaefer,** director of research, **D. G. R. Brigg,** general sales manager, and **H. DePova,** works manager.

From the organization that pioneered
COTTRELL *Precipitators for industry . . .*

WESTERN PRECIPITATION'S New Blast Furnace COTTRELL

with unique radial gas distribution that provides multiple advantages!



Western Precipitation Corporation—*the organization that pioneered the commercial application of* COTTRELL *Precipitators over 45 years ago*—**has developed an improved design of Blast Furnace COTTRELL featuring better gas distribution . . . greater freedom from clogging . . . simpler insulator compartments . . . and many other important advantages.**

Although Western Precipitation has heretofore limited its sales of iron blast furnace COTTRELL *Precipitators to Western United States, Canada, South America and Australia, this new development is for sale throughout the United States as well as all foreign countries.*

A *radial* distribution system—featuring a top center inlet and a deflecting cone—is the key to higher recovery efficiencies in this new unit. Incoming gas is spread equally to each separate collecting electrode pipe, assuring uniform "loading", higher separating efficiency, and many other important advantages as outlined at right.

Companies already installing this efficient new COTTRELL Precipitator include . . .

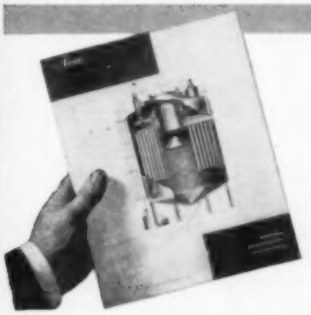
Australian Iron and Steel Ltd.
Crucible Steel Company
Detroit Steel Corporation
Dominion Foundries and Steel Co., Ltd.
Jones and Laughlin
U. S. Steel Company

. . . and others.

Let our experienced field engineers give you full technical data and performance records on this new COTTRELL without obligation. Write for full details!

Advantages of the new Blast Furnace COTTRELL

1. **Gas enters downwardly** through top center inlet.
2. **Gas deflecting cone** provides uniform gas distribution to *all* the collecting pipes in the unit.
3. **Insulator compartments** are above and outside the gas stream, assuring better protection, less maintenance.
4. **Cylindrical design** permits better spacing of collecting electrodes for improved gas flow.
5. **Collected material** is continually washed from inside surface of collecting pipes by film of water from "ponds" in top header. Adjustable weir rings for each pipe assure proper water film, and once set, rarely require readjustment.
6. **Cone bottom** simplifies recovery and disposal of collected material washed from pipes.
7. **Grouping of gas inlet and discharge** connections at the top saves ground area and costly goggle valves, and permits multiple units to be easily manifolded.



There are still other advantages. Get the complete story from our nearest office—or write direct.

Free—Ask for informative new Bulletin C-119 which describes this new COTTRELL Precipitator advancement!

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ONE OF A SERIES:

What makes a cylindrical roller bearing good?

RETAINERS

"requirement-engineered" for your kind of service

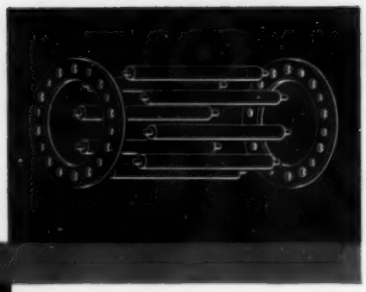
The basic parts of a roller bearing are the rollers, the races, and the *retainer* which locates and guides the rollers. There are significant differences in the design and construction of retainers, which influence bearing cost and performance. Some are simple and economical, well adapted for volume production; others are more costly but insure improved roller guidance, or cooler and smoother operation, or longer heavy-duty service. Here are the seven basic types in current use.

HYATT MAKES ALL SEVEN TYPES . . . EACH THE FINEST OF ITS KIND! **You will find complete details in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type best suited to your requirements. Remember, HYATT is America's *first* and *foremost* maker of cylindrical roller bearings. Hyatt Bearings Division of General Motors, Harrison, New Jersey.**

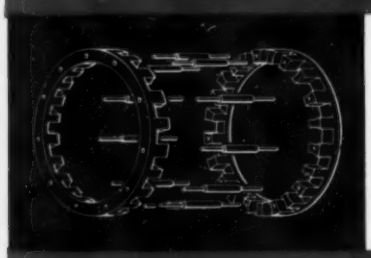
GM GENERAL MOTORS

HYATT

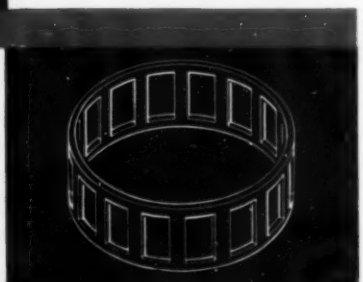
ROLLER BEARINGS



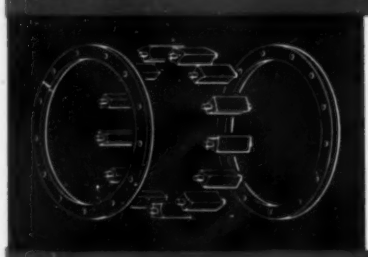
TRUNNIONED ROLLER CAGE—Economical for volume use on thin-annulus bearings. End rings are hardened steel stampings, connected by riveted bars interspersed between rollers to form an integral unit. Races can be omitted if desired.



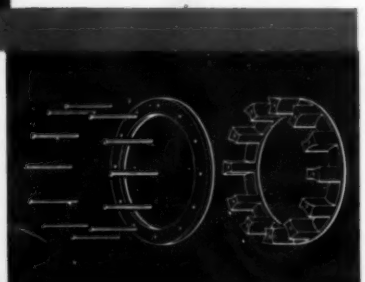
POCKETED END RING CAGE—Designed for fairly large bore bearings in heavy-duty service. Rollers are guided accurately by pockets drilled in bronze end rings. Riveted connecting bars form an integral unit, so races can be omitted if desired.



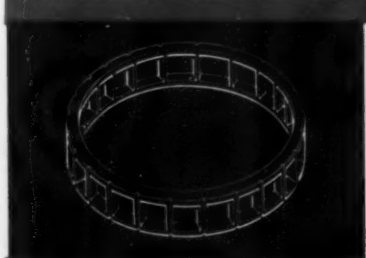
STAMPED STEEL SEPARATOR—Economical for volume use on wide range of bearings with short rollers. A single steel stamping with bars coined to conform to roller contour. Simple, open design assures large lubricant capacity and good circulation.



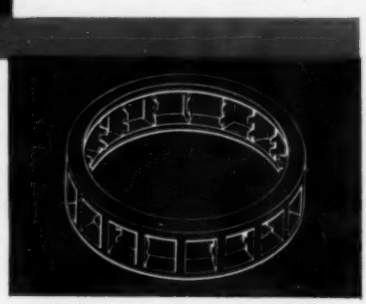
FORMED BAR CAGE—Well adapted for volume use on heavy-duty bearings. Hardened steel end rings are connected by cold-rolled shaped bars conforming to roller diameter. Insures quiet operation, better roller guidance, and the smooth surface of bars protects rollers.



DRILLED POCKET CAGE—Used on better-grade bearings to provide extremely close control of rollers, which operate in pockets drilled and reamed in bronze cylinder. Riveted ring on one end retains rollers permanently, so races may be omitted if desired.



SEPARABLE BROACHED POCKET CAGE—Used only on finest high-speed bearings. An integral bronze cylinder with pockets broached for maximum uniformity. Insures minimum friction, better oil circulation for cooling. Rollers can be removed for inspection.



NON-SEPARABLE BROACHED POCKET CAGE—Similar to the above and offers all the same operating advantages. Used for "blind" installations where rollers must be retained with inner or outer race. Roller drop controlled by deforming bars after rollers are placed.

C. Harvey Bradley has been elected to the board of directors of Jones & Laughlin Steel Corp. Mr. Bradley was president of W. J. Holliday & Co., Indianapolis steel distributors, and of the Monarch Steel Co. at the time of their acquisition by Jones & Laughlin early in 1955.

Clifford N. Cox has been named sales manager of Insul-Mastic Corp. of America.

Robert C. McDowell has been elected president of the Wellman Engineering Co., succeeding **Dr. J. C. Hodge,** who resigned from both the Wellman presidency and board. Mr. McDowell is also president of McDowell Co., Inc., and will serve as both chairman and president of Wellman.

Asa H. Myles, former assistant chief engineer of the Electric Controller & Manufacturing Co., has been named chief engineer and member of the operating committee of the company, now a division of the Square D Co. Mr. Myles has been assistant chief engineer of Electric Controller since 1943.

Henry C. Goodrich has been elected vice president of the Rust Engineering Co. Mr. Goodrich joined the Rust organization in 1946 as a structural engineer and later was project manager on a number of the company's major construction projects. He will now serve as vice president in charge of sales and estimates for the company's Birmingham, Ala., office.

Alexander Carnie has been named chief division engineer of the Truscon Steel Division, Republic Steel Corp. Mr. Carnie, formerly chief division engineer of the company's Union Drawn Steel Division in Massillon succeeds **Ray C. Skeel** who has retired.

K. W. Forster, formerly manager of Industrial Sales of the Lintern Corp., is now a sales engineer with the Alliance Machine Co.

William T. Buchanan, former superintendent of Jones & Laughlin Steel Corp.'s Kansas City Container Division Plant, has been promoted to assistant manager of operations of the J&L Container Division in New York City. **Walter C. Grantham,** former division industrial engineer, New York, has succeeded Mr. Buchanan as plant superintendent at Kansas City.

Elmer B. Dunkak has been appointed to the newly created position of vice president — sales of Selas Corp.

ELMER B. DUNKAK

of America. He had previously been engaged in private engineering practice. For the past 18 months he has served Selas as consultant to the president.

E. W. Prendergast, formerly branch manager of the Atlanta, Georgia office of the Foxboro Co., has been made regional manager of the southeast territory for Foxboro.

Dr. James C. Hodge has been appointed vice president of the Warner & Swazey Co. Dr. Hodge was formerly with the Wellman Engineering Co.

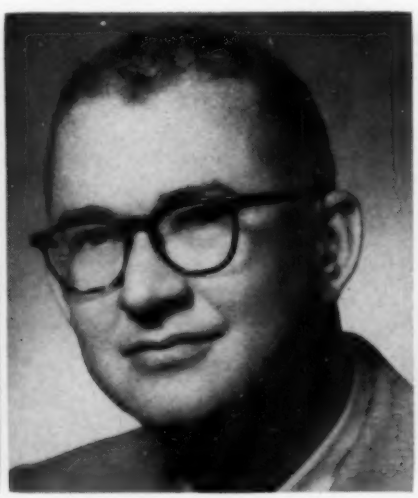
William B. Towner has been appointed general production manager of Foote Mineral Co.

Paul W. Polk was appointed to succeed **John P. Bernard** as executive vice president of the Sheffield Corp.

Fred Reiser, Jr. has been named to the post of manager of Timken Rollenlager GMBH, a recently

CLIFFORD N. COX

ROBERT C. McDOWELL



ASA H. MYLES

HENRY C. GOODRICH

J. HARVEY JOHNSTON

ROY A. GEZELIUS

ALTON B. FENSTERMAKER

FLOYD W. DIEHL, JR.

formed subsidiary of the Timken Roller Bearing Co., with headquarters in Cologne, Germany. The new company is a sales organization set up to serve West Germany.

J. Harvey Johnston, vice president of General Steel Castings Corp., has been appointed a vice president of its subsidiary, The National Roll & Foundry Co. **Roy A. Gezelius** has been named assistant vice president of both companies.

Alton B. Fenstermaker has assumed the duties as project engineer of Mannesmann-Meer Engineering Co., Inc. In addition, **Floyd W. Diehl, Jr.** has been appointed electrical engineer.

Richard A. Geuder was named general sales manager, and **Earl C. Barnes** was named assistant chief engineer of Reliance Electric and Engineering Co. Mr. Geuder has been assistant general sales manager for the

RICHARD A. GEUDER

past year, prior to which time he was manager of industry sales. Mr. Barnes has filled various posts, including a-c motor design engineer, and most recently, manager of engineering for Ashtabula products.

J. D. A. Morrow, formerly president of Joy Manufacturing Co. was elected chairman of the board. At the same time **John Lawrence** was named president and chief executive officer, **W. L. Wearly,** executive vice president, and **H. C. Nyguist,** vice president, general sales

John E. Duesing has been appointed sales manager of the mechanical division of Hagan Corp., replacing the late **Gerald G. Lipke.** Mr. Duesing had only recently been named general manager of Dominion Flow Meter Co., Limited, a Hagan subsidiary. He was formerly Pittsburgh district sales manager of Hagan Corp.

H. K. Intemann has been appointed executive vice president of Electro Metallurgical Co., Division of Union Carbide and Carbon Corp.

Charles W. Yutmeyer, formerly superintendent of the Electric Furnace Melting Department at the Midland Works of Crucible Steel Co. of America, has been appointed superintendent in charge of the open hearth and electric furnace melting departments at Midland.

Frank L. Merwin has been appointed assistant general traffic manager for Kaiser Steel Corp.

John R. Patton has been named Atlanta district sales manager for National Electric Products Corp. Mr. Patton joined National Electric in 1947 and served in the sales office at Charlotte, N. C. Prior to his recent promotion, he was in charge of marketing the company's electrical materials throughout the state of Fla.

H. Stanley Butterworth, former manager of Jones & Laughlin Steel Corp.'s Container Division plant in New Orleans, La., has been appointed assistant general manager of the J&L Container Division with headquarters in New York City.

William T. Ritchie has been named general foreman of the Machinery Division of the Pratt & Whitney Co. At the same time, **Dominic Ricardo** had been named to succeed Mr. Ritchie as head of the company's milling department.

Richard J. Coveney has been appointed a vice president of Arthur D. Little, Inc. Prior to joining Little,

"More Combustion Information with Cities Service Heat Prover"

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in 1949, Mr. Coveney was associated with Linde Air Products Co., Ethyl Corp., and the Fram Corp. in product research and development and technical sales development.

HERBERT B. NECHEMIAS

JOHN K. OLIVER

Herbert B. Nechemias was appointed manager of Wagner Electric Corp.'s Cincinnati, Ohio, office. At the same time, **John K. Oliver** was named manager of the Portland, Ore., office.

Obituaries

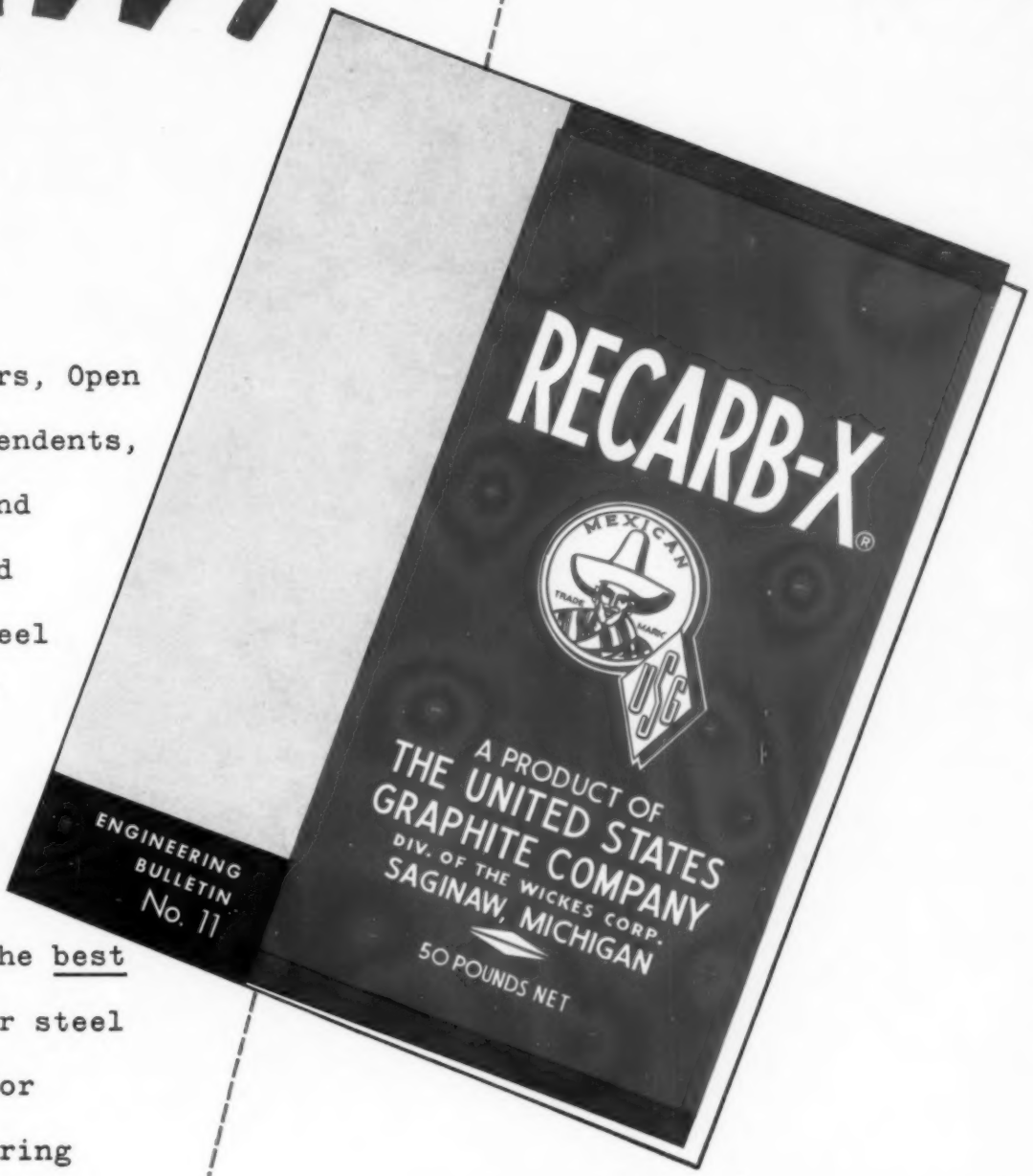
W. M. Reed, 63, founder and chairman of the board of the American Air Filter Co., Inc., died February 2.

Roland A. Hess, electrical engineer of Armco Steel Corp., died January 22.

Frank W. Dine, 64, chairman of the board, Stamco, Inc., died January 6.

Rudolf Unfug, an architect-engineer for the Rust Engineering Co. during the past 36 years, died February 1. Mr. Unfug joined the Washington, D. C. office of the Rust organization in 1920, and in 1935 moved to Pittsburgh, Pa. where he served in the company's headquarters office for eleven years. In 1946 he returned to Washington, working from that office until shortly before his death.

NEW!



a memo to Melters, Open Hearth Superintendents, Metallurgists and others concerned with quality steel making . . . If you haven't tried RECARB-X and want the full facts on the best recarburizer for steel making, write for the new Engineering Bulletin No. 11, use the convenient coupon below.

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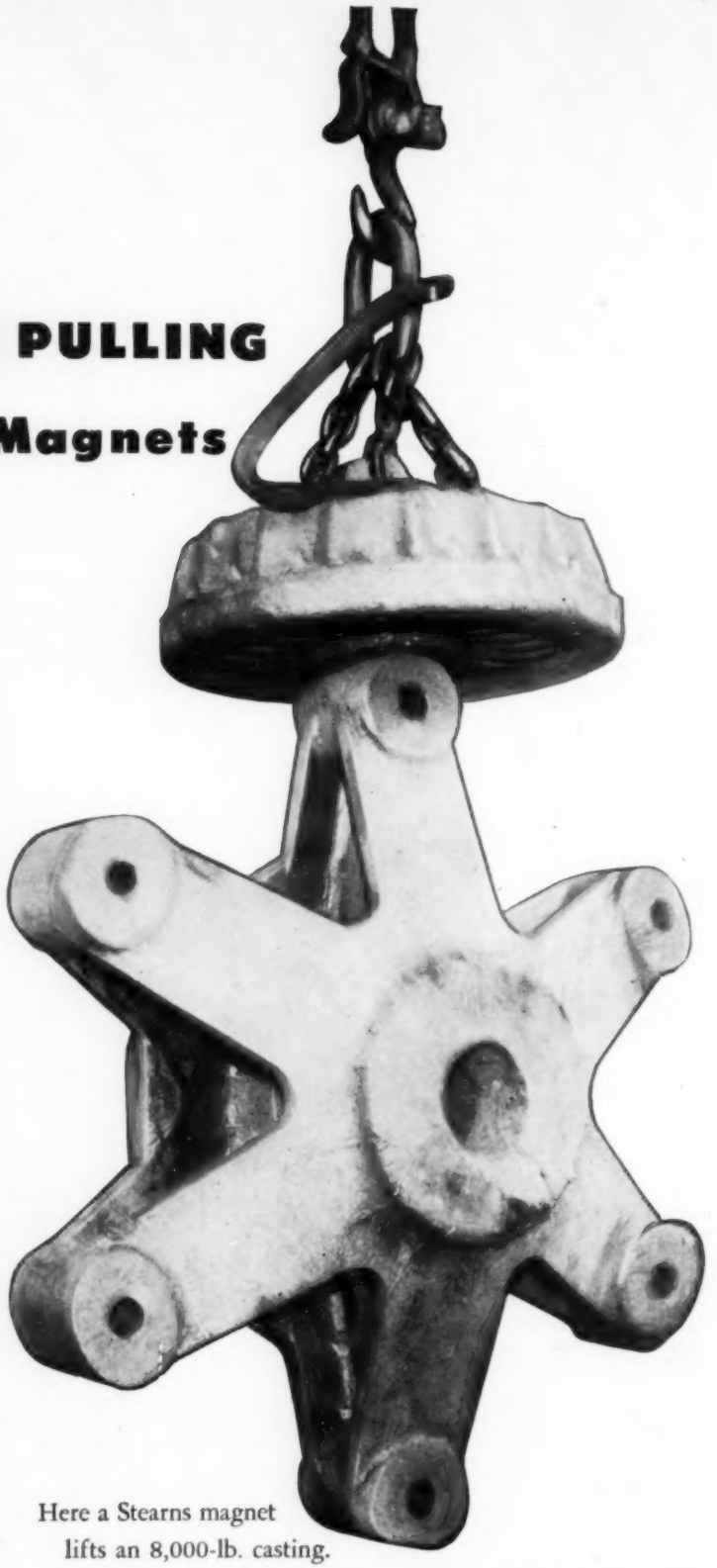

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(1) Cable Data Book

The Okonite Co., has released a complete 48-page data book on heat-resistant cables. Typical test results are given for butyl rubber insulation under conditions of high heat and extreme moisture. This new manual includes dimensional tables for power and control cables for direct burial and duct use as well as 24 pages of valuable engineering information helpful in selecting and applying the proper cable to the specific job. Tables, formulas and graphs on such subjects of interest as: current carrying capacities, full-load currents of motors, voltage drop, short circuit currents and methods for determining conduit sizes are included in this valuable reference manual. (Bulletin H-463)

(2) Tube Mills

A revised edition of Yoder Co.'s booklet discussing tube mills is available. This 65-page booklet gives data on design, construction, operation and maintenance of electric resistance tube mills. Also included are illustrations of Yoder machinery and engineering data and specifications.

(3) Rotary Control and Instrument Switches

An eight-page bulletin that points to the operating advantages of a-c rotary control and instrument switches has been published by Allis-Chalmers Manufacturing Co. Actual installations on vertical and bench-type control boards are illustrated. The bulletin includes a table of ratings, outline of dimensions and photos of rotary switches for special requirements. Important features of these switches such as flexibility, accessibility and dependability are also described. (Bulletin 14 B 8112)

(4) Marking Handbook

Jas. H. Matthews & Co., Inc., has issued a manual describing steel marking dies. This complete manual is packed with information on the use and selection of steel dies for every application, steel stamping, embossing and foil leaf marking dies, and numbering heads for embossing or debossing. Profusely illustrated, the booklet discusses press-style type holders, tool post holders for marking around the peripheries of cylindrical or round-tapered parts, and gives specifications for standard automatic numbering heads. (Catalog 146-B)

(5) Aluminum Bronze Alloys

Facts about the properties, composition and functions of aluminum bronze alloys are given in a bulletin published by WW Alloys, Inc. A complete section on engineering data describing each grade of alloy, a specification index chart for comparison, and machining recommendations and tool geometry are included. (Bulletin No. 15.100-1)

(6) Furnaces

A new bulletin describing furnaces for the heating and heat treatment of aluminum and other light metal alloys from the ingot to the finished product has just been issued by Surface Combustion Corp. This bulletin covers all types of furnaces, both batch and continuous, including soaking pits, coil annealers, continuous process roller hearth furnaces, batch type units for heat treating, and melting, as well as investment casting. Important data on extremely rapid heating with high speed convection is also included. (Bulletin SC-171)

(7) Industrial Brushes

An eight-page booklet featuring a general purpose industrial motor and generator brush has been published by National Carbon Co., a Division of Union Carbide and Carbon Corp. A number of "in-service" reports define the brush's record on main drive motors and generators, rotary converters and heavy-duty motors. The booklet contains a graph comparing the commutating ability versus brush life, the graph shows how the brush exceeds in both long life and commutating ability.

(8) Steel Raceways

A new 20-page booklet complete with information on heavy-wall and thin-wall steel raceways has been published by General Electric Co. This booklet covers galvanized and black enameled rigid steel conduit, electrical metallic tubing, and plastic-coated steel conduits. In addition to complete descriptions and specifications, the booklet contains a number of data tables on allowable conduit and EMT fill for various cable types. Considerable test data is also included. (No. 18-255)

(9) Refractory Specialties

The Ramtite Co. has issued a new 16 page catalog describing plastic and castable refractories, cements and mortars from packaging to completed installation. It also outlines many applications in ferrous and non-ferrous metal furnaces, aluminum reverberatory melting furnaces, annealing ovens and heat treating furnaces. Typical applications and suggestions on how to use plastics, castables, cements and mortars, are also included.

(10) Variable-Speed Drives

A new four-page bulletin entitled "How to Care for Jr." has been published by Reliance Electric and Engineering Co. The bulletin describes and illustrates the simple, but comprehensive program available to keep these drives in operation at peak efficiency. The bulletin explains the complete line of services and parts available for these electronic variable-speed drives. It discusses how a preventive maintenance program may be set up in relation to such factors as the number of units in operation

or the specific type of operations. The "Renewal Parts Kits" plan supplies a complete kit of replacement parts, the "Replacement Exchange Panels" plan affords fast replacement of complete control panels, and the "Standby Panels" plan offers the user the option of establishing his own control panel replacement setup. Also included is a complete listing of parts and prices, and instructions on how the various plans may be put into effect. (Bulletin H-2104)

(11) Hardness Tables

Hardness conversion tables for steels have been published by the International Nickel Co., Inc. These tables give approximate relationships between Brinell, DPH (Vickers), Rockwell and Shore Scleroscope hardness values and corresponding tensile strengths of steels.

(12) Inverted-Y Conductors

The Cleveland Crane & Engineering Co., has recently published a catalog on its line of Inverted-Y electrification for cranes and runways. The booklet contains drawings and all information necessary for ordering the aluminum conductors, supports, and collectors which have been made available by the company for the first time for normal applications requiring current in the amounts of 300 to 1000 amp. (Catalog No. 2021-A)

(13) Blast Cleaning Abrasive

A bulletin describing a cast steel, heat treated, blast cleaning and peening abrasive, has been published by Wheelabrator Corp. This eight-page illustrated booklet discusses the automatic process and quality control exercised in the company's new manufacturing plant. The plant is the largest of its kind in the world and is completely mechanized. Electric arc melting furnaces and automatically controlled heat treating equipment assure constant uniformity of product. A description is also given of the pilot plant used for research and development. Other interesting sections of the booklet include a tabular comparison of the characteristics of the various types of metallic abrasives. Also included is a discussion of the factors important to the economical and efficient consumption of abrasive. Performance data on the abrasive is presented from various industries. Such data includes the specific application, the size of abrasive used, and cost data (both with this abrasive and others at the same plant). (Bulletin 89-B)

(14) Liquid Level Transmitter

The Foxboro Co. has issued a new eight page bulletin describing closed tank liquid level measurement and control with the recently announced Type 13 LA d/p cell liquid level transmitter. The bulletin contains diagrams showing principle of operation and suggested installation layout. Also included are illustrations of other Foxboro liquid level components such as indicators, recorders and control valves. (Bulletin 13-22)

(15) Graphite Charge

An instructive bulletin which tells in detail the methods of using Recarb-X as a carbon source for furnace charge of ladle recarburization has been published by The United States Graphite Co. The bulletin presents data on the efficiency of Recarb-X under various conditions, and explains how it should be added in each case. Information is given on all phases of the use of Recarb-X with rimming steel, in basic open hearth, acid open hearth, recarburizing soft heats, for pin point deoxidation, and in electric furnace. (Engineering Bulletin No. 11)

(16) Stoves and Checkers

A four-page bulletin describing the Kennedy checker for lining and relining blast furnace hot stoves has been released by William M. Bailey Co. Included in the bulletin are diagrams of the stoves using these checkers.

(17) Air Conditioning

The Lintern Corp., has issued a 20-page catalog on Air Conditioning Units for crane cabs, pulpits, and heat relief rooms. The booklet covers applications for every temperature range and size for overhead cranes and pulpits. (Bulletin 561).

(18) Gear Motors

Available from Link-Belt Co., is a 28-page booklet covering the company's new line of gear motors. Features of construction, load classifications, dimension tables, overhung load ratings and mounting assemblies are included. Fully illustrated, the book contains selection data as well as pictures of couplings and other related equipment. (Book No. 2447)

(19) Electric Fork Trucks

Described in bulletins available from the Baker-Raulang Co., are two new electric fork trucks. One of the bulletins describes the FT-40 4000-lb truck, and the other contains details on the FT-60 6000-lb truck. These six page illustrated bulletins list performance specifications, dimensions, and details on controls and construction. (Bulletin 1324-C, 1325-D)

(20) Heat Radiation Detectors

Recently published by Leeds and Northrup Co., is a 24-page illustrated catalog describing their complete line of rayotube (heat-radiation) detectors, for continuous temperature measurement to 5000 F and beyond. The booklet discusses the theory behind heat-radiation measurements of actual surface temperatures and furnace atmospheres, describes construction, and tabulates the characteristics of the detectors available. It lists complete assemblies for both general and specialized applications. (Catalog EN-S3)

(21) Cable Selection Charts

The Okonite Co. has issued a new 16-page general catalog which lists all trade names, products and their applications. Also included are two selection charts —one by application and environment and one by cable type. These charts are a practical guide in selecting the best insulated electrical cable for each condition of use. Minimum standard industry specification requirements are also listed for each insulation and covering where applicable. (Bulletin 1096)

(22) Flow Meters

Mechanical flow meters with evenly graduated charts and scales are described in a specification sheet issued by Minneapolis-Honeywell Regulator Co. The four-page sheet discusses the flow meters purpose, construction, and specifications. Diagrams of the meter and charts are also included. (Specification Sheet 242-2)

(23) Clutch Controls

Features and specifications of high-speed clutch controls are described in a bulletin recently published by Fawick Airflex Div., Fawick Corp. Standard and optional features are listed for three sizes of control panels. Additional uses in connection with their other products for modernization of old presses and more efficient opera-

tion of new presses are suggested. (Form ML-134)

(24) Wire Machines

Available from Lewis Machine Co., is a 16-page brochure discussing wire straightening and cutting machines. Complete data on sizes, capacities and speeds of both stationary cut-off and flying-shear cut-off type machines is given. In addition, ten wire reels of various types are charted, covering most commonly used sizes and capacities, with complete measurement and weight data. Brochure No. (M 55-3)

(25) Panelboards

"Modern Panelboards" is the title of a 75-page catalog published by Federal Pacific Electric Co. Illustrated with photographs, drawings, diagrams and specifications, the manual describes the features and construction of each panelboard and assists in their application. Circuit breakers as well as fusible disconnect devices used in lighting and distribution panelboards are described in detail. Among the engineering data included is information on transformer connections for distribution voltages, and circuit breaker characteristics. (Catalog No. 3-205)

(26) Ultrasonic Inspection

Sperry Products, Inc., has released an eight-page bulletin on the application of an ultrasonic reflectoscope for non-destructive detection and location of defects in materials. The bulletin illustrates the uses of this unit, and explains in simplified terms the principal of ultrasonic inspection, as well as presenting the latest types of equipment available. (Bulletin No. 50-105)

(27) Gas Carburizers

Surface Combustion Corp. has published a new bulletin on furnace equipment for gas carburizing. The booklet describes the process of adding carbon to ferrous alloys, and lists the advantages of their continuous gas carburizers. Also included are illustrations of these controlled atmosphere furnaces. (Bulletin Sc-172-1255)

(28) Slitting Equipment

Available from Waterbury Farrel Foundry & Machine Co., is a 24 page booklet describing slitting equipment. The booklet gives details on various slitter types as well as payoffs and coil boxes, loaders, straighteners, feed rolls, back rolls, winders and coilers, and stripper fingers. Also included are specifications and a cutting capacity chart. (Circular No. 898-S-2)

(29) Fire Resistant Hydraulic Fluid

E. F. Houghton & Co., has released an eight page bulletin on a new fire resistant hydraulic fluid. The bulletin contains factual information on installation and maintenance of this safe fluid where potential fire hazards exist. Technical data is given on installation as relating to packings, pumps, strainers, filters and other parts of the system. The importance of pumpability at low temperature and storage stability are also covered. Typical uses of this fluid are outlined in the folder, which also summarizes the advantages of the product and includes testimonials from users.

(30) Magnetic Brake

A new booklet, entitled "Brake Adjusting Completely Eliminated," is offered by the Westinghouse Electric Corp. The booklet describes in detail the construction, operation, and applications of a new completely self-adjusting d-c magnetic brake. The brake is suitable for all types of d-c motors. Through the use of rectifiers, the brake can be applied to a-c motors. (B-6548)

(31) Welding Data Card

The Tubular Products Division of The Babcock & Wilcox Co. has issued a data card which summarizes the various recommendations for joining, by arc welding procedures, various tubing steels. In addition to indicating the proper electrodes to use, it provides information about preheating and postwelding heat treatments. Anyone who has occasion to weld stainless steels and chromium molybdenum alloy steels in tubing and other forms will find this a valuable reference card. (TDC-155A)

(32) Solvent Detergents

The cleaning uses of solvents compounded with surface active agents are described in a booklet issued by Oakite Products, Inc. The booklet tells how solvent detergents, used without heat, remove oily films, smuts, cutting, drawing and stamping compounds, and synthetic paints from steel, while providing temporary protection against rust painting. Methods of application are described in detail, including procedures and solution cencentration.

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52	ALDRICH PUMP CO., THE		Direct flow pumps.
53	AMERICAN AIR FILTER CO., INC.	BULLETIN 252-E3A	Electrostatic precipitators.
54	AMERICAN BRIDGE DIVISION, U. S. STEEL CORP.		Heroult electric furnaces.
55	ASKANIA REGULATOR CO.	BULLETIN NO. 161	Edge position control.
56	BAILEY METER CO.	SPEC. E12-5	Recorders.
57	BRISTOL CO.	BULLETIN P1260	Automatic heating controls.
58	BROOKS OIL CO.		Lubrication.
59	BUFFALO FORGE CO.	BULLETIN 2424-E	Rubber-lined exhausters.
60	CHEMICAL CONSTRUCTION CORP.	BULLETIN M-102	Venturi scrubber.
61	CHEMICAL CONSTRUCTION CORP.	BULLETIN M-103	Fume applications in the steel industry.
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63	CUTLER-HAMMER, INC.		Welded, bolted and special magnets.
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65	DIAMOND POWER SPECIALTY CORP.		Industrial wired television.
66	DRAVO CORP.	BULLETIN NO. 225	Bridges, unloaders, trolleys and other equipment.
67	ELECTRIC CONTROLLER & MANUFACTURING CO.	BULLETIN 9300	A-c hoist control.
68	ELECTRIC MACHINERY MFG. CO.	FOTO-FACTS NO. 16	Modern motor applications.
69	FRANTZ CO., INC., S. G.	BULLETIN PM-44	Filter magnetic separators.
70	GEAR GRINDING MACHINE CO., THE		Constant velocity universal joints.
71	GENERAL ELECTRIC CO.	BULLETIN GEA-5994	Rotary limit switches.
72	GENERAL ELECTRIC CO.	BULLETIN GEA-5408A	D-c crane control.
73	GENERAL ELECTRIC CO.	BULLETIN GEA-6307	Drum switches
74	GENERAL ELECTRIC CO.	BULLETIN GEA-6214	D-c brakes.
75	HOMESTEAD VALVE MFG. CO.	BOOK 39-5	Controlled pressurized lubrication.
76	HYATT BEARINGS DIVISION, GENERAL MOTORS CORP.	CATALOG NO. 150	Cylindrical roller bearings.
77	JOHNS-MANVILLE CORP.	BROCHURE PK-71A	Oil seals.
78	KAY LAB		Industrial television.
79	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Engineering drawings, capacity tables, etc., on couplings.
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81	MINNEAPOLIS-HONEYWELL REGULATOR CO.	CATALOG 1531	Control with electronic instruments.
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83	OHIO CRANKSHAFT CO., THE		Induction heating and heat treating.
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85	PANGBORN CORP.	BULLETIN NO. 224	Automation for fabricators.
86	POST-GLOVER ELECTRIC CO., THE	BULLETIN NO. 510	Welded steel grid resistors.
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91	WAGNER ELECTRIC CORP.	BULLETIN MU-203	Fan-cooled motors.
92	WESTERN PRECIPITATION CORP.	BULLETIN C-119	Blast furnace cottrell precipitators.
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businesspaper

Where There's Business, There's Advertising

Wherever business is done, you see the signs of America producing more goods — and selling 'em to more people — than ever before . . . And as the nation's assembly lines roll faster and faster, you have got to run, not walk, to keep up. You can keep pace — and probably do — by reading everything that concerns your job . . . in your businesspaper.

And that's true of most of the men and women who are responsible for making business boom. By keeping tuned in on the intercommunications system of the business press . . . getting all the important news of their fields fast . . . detailed data on the latest advances . . . ideas that generate ideas . . . they are able to keep ahead in the hot race for more production and consumers' dollars!

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This year, advertisers are spending over 1430 million to report on their products and services in specialized businesspapers. Your share of that investment is here, in the pages of this paper of yours. Nowhere else can you find such a complete, useful source of everything you need in your business. Read it thoroughly . . . put it to work . . . and let your competitors watch your smoke!

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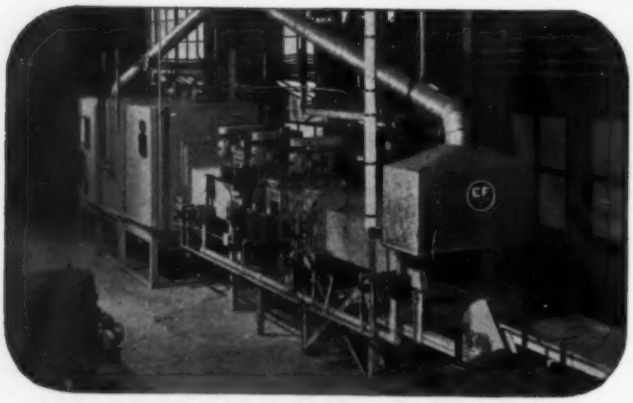
IRON AND STEEL ENGINEER

Prepared by the Associated Business Publications, in cooperation with Advertising Federation of America, in the interests of better understanding of advertising.

Straight lengths of brass and copper tubing are also bright and scale-free annealed in this EF gas fired furnace. Capacity 4000 lbs. per hour.

EF gas fired forced convection continuous roller hearth special atmosphere furnace bright annealing long straight lengths of tubing.

ANNEALING TUBING BRIGHT *and* CLEAN *Continuously*



A special atmosphere belt conveyor electric furnace annealing short lengths of alloy tubing—operates at temperatures up to 2040° F.

• We have built many outstanding production furnaces for processing copper, brass, stainless, aluminum, nickel silver and other ferrous and non-ferrous tubing . . . in large and small coils . . . straight lengths, long and short, and in various diameters . . . also for wire, strip, stampings and many other products and processes.

Pur your production furnace problems up to experienced engineers . . . *it pays.*

3000 lbs. of steel tubing, per hour, are bright normalized in this EF gas fired radiant tube type special atmosphere furnace.

Straight lengths of tubing up to 5" in diameter and ¾" thick are also annealed in this EF forced circulation roller hearth furnace.

Gas-Fired, Oil-Fired EF and Electric Furnaces

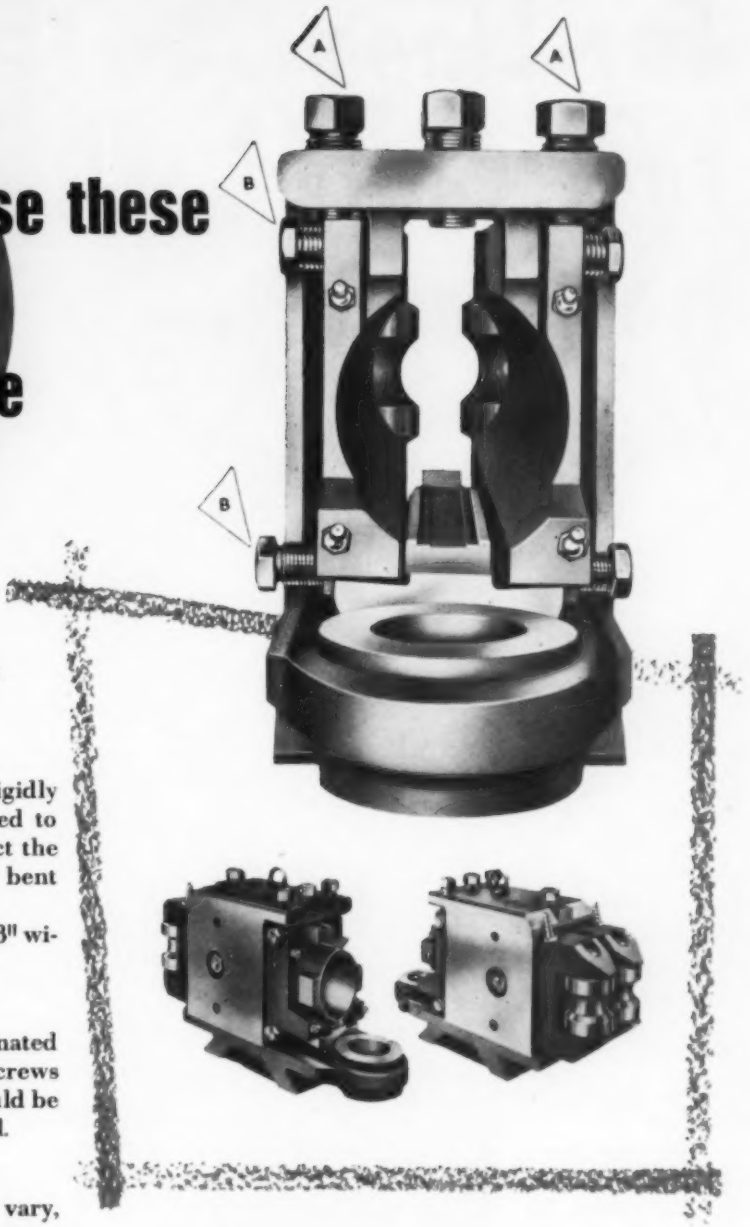
for any Process, Product or Production

THE ELECTRIC FURNACE CO.

WILSON ST. at PENNA. R. R. *Salem - Ohio*

Canadian Associates • CANEFCO LIMITED • Toronto 1, Canada

8 good reasons why you should use these ROLLER GUIDES in your bar or wire rod mill



The Morgårdshammar Roller Guides — patented in most countries of industrial importance — are constructed according to the following principles:

1 The entry friction guides are rigidly clamped into the guide box. They are intended to lead the oval to the groove in the roller, to protect the rollers against overloading, and to straighten bent rods.
The groove in the entry guides is made about 1/8" wider than the oval.

2 The rollers are mounted on laminated springs, which can be adjusted by means of the screws "B", and hold the oval steadily even if there should be some slight variation in the thickness of the oval.

3 If the thickness of the oval should vary, the springs of both rollers yield an equal amount, so that the oval remains in the centre of the groove.

4 To tilt the oval, the screws "A" are adjusted as shown by the arrows. One roller will then be lifted as much as the other is lowered.

5 As the oval is held very rigidly, the leader oval for wire rod may be plump, unless other circumstances call for a thinner oval.

6 The roller guide assemblies are narrow, and all screws that require adjustment during rolling are accessible from the front of the mill. No lateral space outside the guide box is therefore required for gaining access to the set screws, and the guide box assembly can thus be located close to the mill housing.

7 As the groove in the entry guides is wide and nothing but rolling friction acts on the oval, the latter is very easily introduced into the pass, and there is practically no risk of scratching the bar.

8 The roller guide may be used not only for leader and break-down oval passes but also for edging flats as well as for rolling squares, hexagons, octagons and various other sections, for instance in reduction passes for hexagon. It is suitable for all types of rolling mills. An important advantage is that the roller guide enables repeaters to be used in rolling plump leader-ovals.

P.S. *Practically speaking, every bar and wire rod mill in Scandinavia uses roller guides of our design.*

MORGÅRDSHAMMAR

MORGÅRDSHAMMARS MEK VERKSTADS AB • MORGÅRDSHAMMAR • SWEDEN

For the complete story — send for your copy of bulletin L3—1E.

Telegrams: Morgårdshammar, Ludvika
Telephone: Ludvika (0240) 71100

For Lines that Carry Hot Corrosive Gases

This W. S. Rockwell Monel metal, double disc, wedge locking type gate valve—in 36" x 42" and larger pipe size—was built for coke oven by-product lines. It controls the flow of hot gases containing a high percentage of corrosive sulfuric acid and ammonium sulfate.

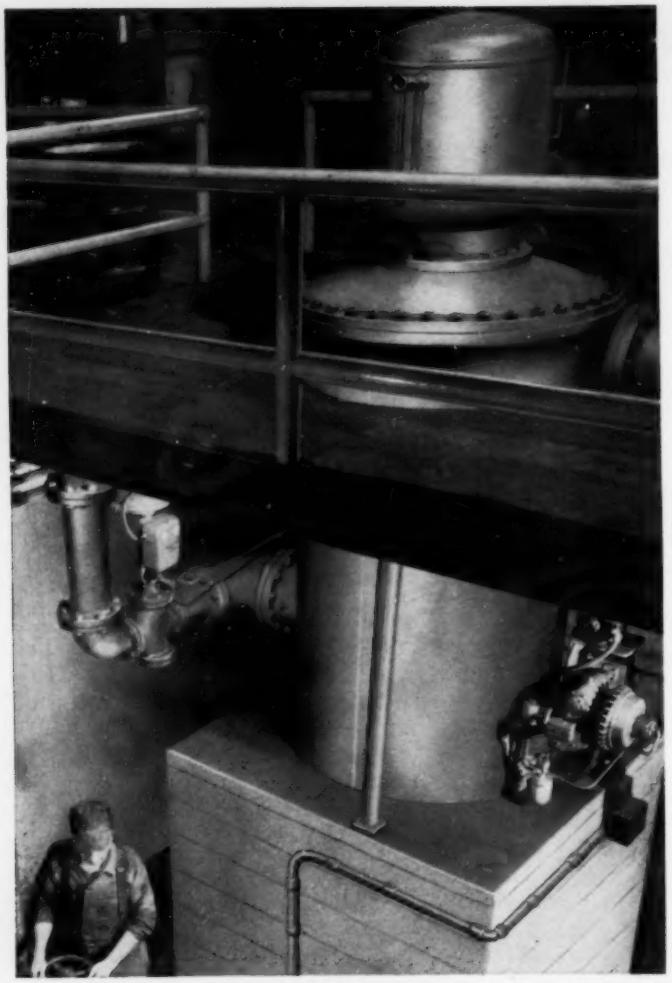
The valve has a drain connection in the bottom, and a coupling in the bonnet for water sealing. Operation is by hand wheel (on floor stand) through a shaft and gears to valve stem; it may also be operated by hand wheel from above, or automatically by hydraulic, pneumatic or electric operator.

W. S. Rockwell valves are made in many types and materials of construction for handling air and gases, from sub-zero to 1600° F., cooling water, process fluids and granular solids. These are available in butterfly, slide, gate, swing gate, check and other types. Write for catalog.

W. S. ROCKWELL COMPANY

2426 Eliot Street • Fairfield, Conn.

Sales Representatives in Principal Cities



This Adams AWF filter has been protecting expensive test equipment for years . . . another example of how Adams saves money in making steel.

Here's proof positive ADAMS FILTERS save you money!

Several leading steel manufacturers test tubing with high pressure water from a multi-stage pump. Damage to the pump and expensive test equipment would cause costly lost production and repair bills. Frequently the R. P. Adams Company has supplied the needed protection — an Adams AWF filter.

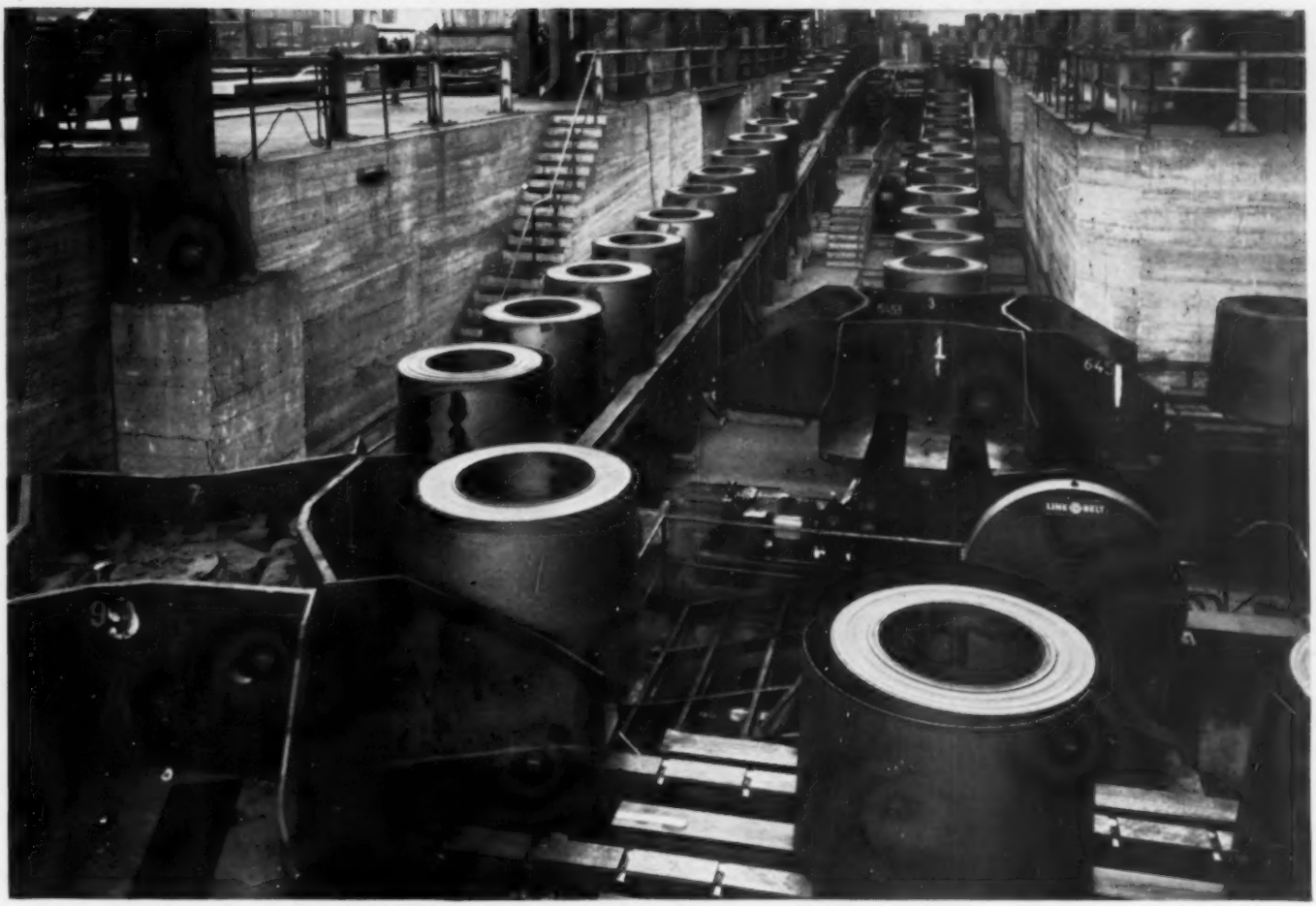
RESULTS — Under constant production use these Adams automatic water filters have removed from the test water all foreign matter that would damage the pump and test equipment. Also, they afford a large saving in water thru recirculation.

Adams filters can save you money, too.
Write today for Bulletin 691.

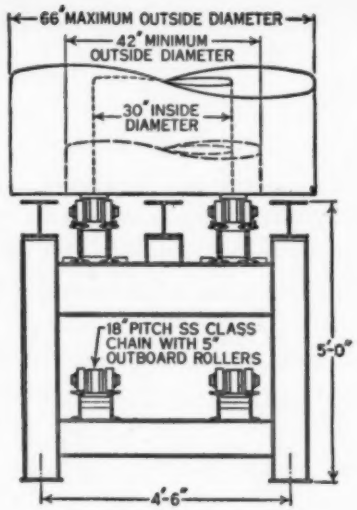
R. P. ADAMS CO., INC.

223 E. PARK DRIVE BUFFALO 17, NEW YORK

How these LINK-BELT coil conveyors provide FASTER COOLING, EXTRA LIFE



In mill at Denain, France, two Link-Belt conveyors carry coils from downtilters to lift-and-turn transfers, which deposit them on a 6-degree inclined conveyor moving to storage.



Link-Belt chain designed for use on these conveyors has ultimate strength of 340,000 lbs., 18-in. pitch, and is supported by 5-in. dia. cold rolled steel outboard rollers. Despite constant exposure to intense heat, chains continue to give excellent service after 3½ years. In cross-section drawing of conveyor, note how construction facilitates cooling.

First French hot strip mill gets maximum safety, minimum scuffing

When United Engineering and Foundry Co. of Pittsburgh was appointed to build France's first continuous hot strip mill, it turned over to Link-Belt the job of designing and furnishing a conveyor system with capacity for handling 25,000-lb. red-hot coils from coilers to storage area. Adding to the challenge was the need for fast cooling prior to storage.

Resulting Link-Belt facilities carry from 500 to 550 coils during an average 18-hour work day . . . on four extra-rugged chain conveyors totaling 600 ft. in length. Each coil is supported in a manner which permits free circulation of air around and beneath it, thus lowering temperatures sufficiently to lessen scuffing when coils are unloaded.

Willing to work with your own engineers and consultants . . . able to satisfy both normal and special requirements — Link-Belt engineers are qualified to bring you the best in modern steel or raw materials handling. A call to your nearby Link-Belt office will put this extensive background and the complete Link-Belt line of mill and process equipment at your disposal.

LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION EQUIPMENT

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,930

PENNSYLVANIA

suggests you consider

Fire and Explosion resistant

2000 Kva Group 3 Sealed-in Nitrogen Dry Type Transformer. H. V.—2400Δ volts. L. V.—480Δ volts. Three Phase. One of the largest Silicon-Insulated transformers ever built.

SILICONE-INSULATED TRANSFORMERS for Indoor Unit Substations

When planning an indoor unit substation, plan to install the safest substation transformer ever developed — a Pennsylvania Silicone-Insulated, sealed-in-nitrogen 150°C. Rise Dry Type Transformer.

Since oil-filled transformers constitute a fire risk, they cannot be used safely indoors unless expensive vaults and barriers are erected. And though askarel-filled transformers are installed indoors without vaults or fire barriers, they have been known to give off toxic HCl vapors under arcing. This constitutes a hazard to personnel. Therefore, Askarel transformers must be provided with gas absorbers or they must be vented to the outside air.

Pennsylvania Silicone-Insulated Transformers can be installed indoors "as is", without expensive vaults and other costly safety devices because inherently, they are the safest transformers ever developed. But safety is only one of their many advantages, for these "safest" dry type transformers also feature *smaller size, greater overload capacity, decreased cooling time, resistance to dirt and moisture, and minimum requirements for maintenance.*

If you want to know more about the Pennsylvania Silicone-Insulated Transformer — formerly called Class H — see your Pennsylvania representative or write to Pennsylvania Transformer Company, Box 330, Canonsburg, Pennsylvania.

PENNSYLVANIA TRANSFORMER COMPANY

A McGraw Electric Company Division • CANONSBURG • PENNSYLVANIA

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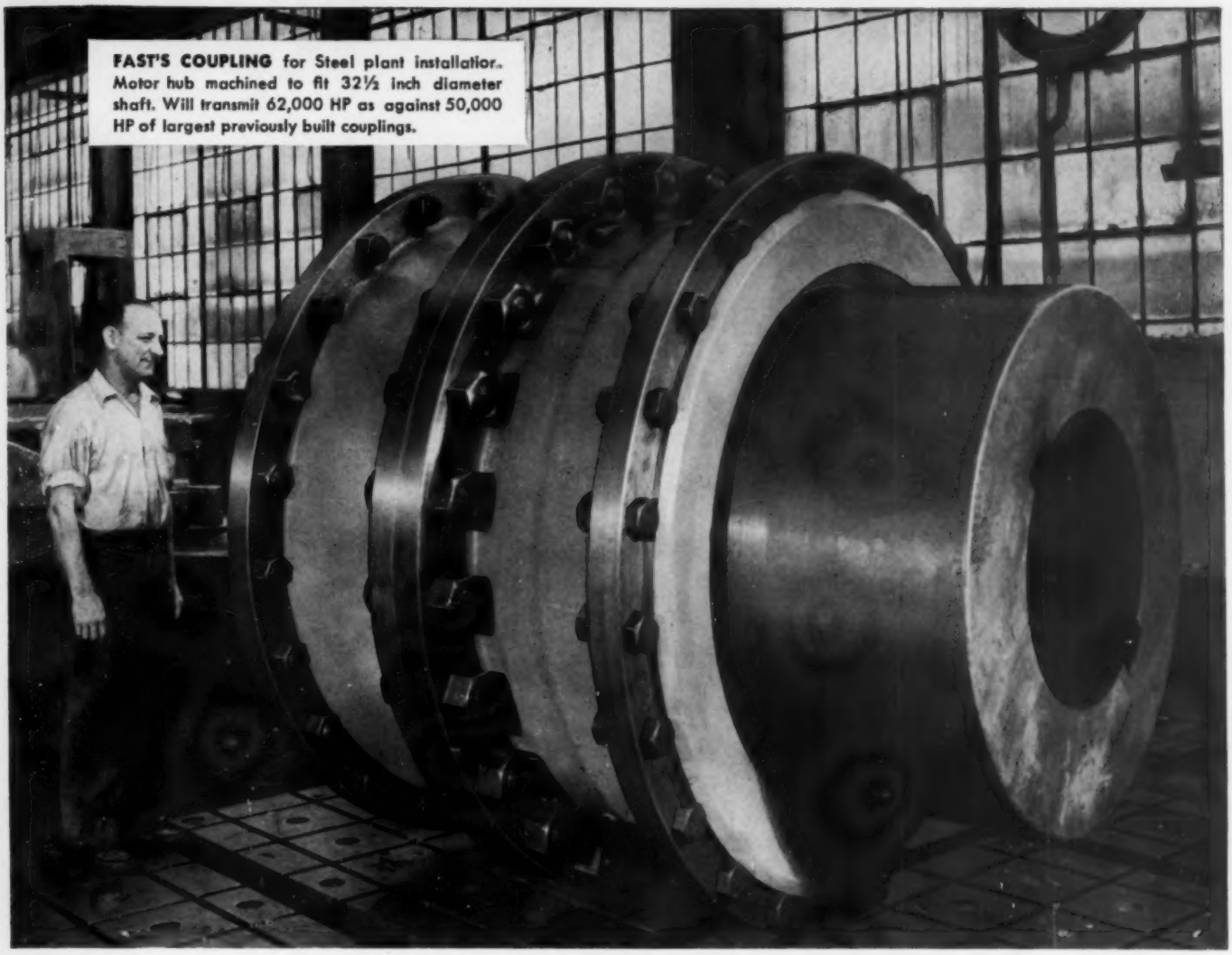

FAST'S COUPLING for Steel plant installation. Motor hub machined to fit 32½ inch diameter shaft. Will transmit 62,000 HP as against 50,000 HP of largest previously built couplings.

WORLD'S LARGEST INDUSTRIAL GEAR-TYPE COUPLING

To make a coupling that will transmit 62,000 HP and compensate for errors in alignment . . . that's more than a man-sized job.

But Koppers took on the project and this Fast's Self-Aligning Coupling is the result.

After six months of machining and assembly, this huge, *all metal* coupling is on its way to installation in a Milano, Italy, steel mill where it will carry power to a Mesta, 110-inch, four-high reversing plate mill.

It will transmit power from an electric motor to the equipment, and, at the same time, compensate for shaft misalignment and lateral float, give maximum power transmission efficiency, eliminate breakdowns and costly down-time.

WHAT'S YOUR COUPLING PROBLEM?

This mammoth Fast's Coupling is just one example of the outstanding jobs which Koppers is equipped to handle. 35 years of manufacturing "know-how" go into the production of *all* Fast's Couplings, large and small alike. Engineering specialists, experienced in designing Fast's Couplings for special applications, are well equipped to solve your coupling problems.

Remember, there's a Fast's Coupling for every power transmission application. Next time you have a coupling problem, call on Koppers . . . always ready to serve you. No obligation, of course. Also, for full details on Fast's Couplings for industry, mail this coupon.

THE ORIGINAL **FAST'S Couplings**

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus.

Engineered Products Sold with *Service*

KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 3002 Scott St., Baltimore 3, Md.

Gentlemen: Send me FREE, Fast's Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.

Name .....

Company .....

Address .....

City ..... Zone ..... State .....

Trabon Automatically Lubricates thru HEAT and DIRT . . . . .

TRABON automatic lubrication systems assure proper flow of oil or grease to bearings in hot and dirty places.

TRABON builds in these features . . . . . .

Central warning signal telling operator immediately of interruption in flow of lubricant; shut-off device to stop machine. **Production insurance against burned out bearings.**

Positive piston displacement in metering valves gets right amount of lubricant to bearings, at the right time. **Saves dollars spent on lubricating idle machinery.**

Simple, single line designs, using standard components, provide easy installation and maintenance. **Any number of bearings lubricated by one simple system.**

Address your automatic lubrication inquiries to the maker of The World's Finest Automatic Lubrication Systems . . .

Trabon ENGINEERING CORPORATION
1814 E 40th STREET • CLEVELAND 3, OHIO
Oil and Grease Systems

Equipment News...

FLAW DETECTOR

American Steel & Wire Division of United States Steel Corp., is using a new tool to detect flaws or defects in the final inspection of wire rope products.

This electronic detecting device is a major step in the development of scientific quality control in the wire rope industry. The unit can detect a defective single wire in a group of upwards of 222 individual wires stranded together.

The basic principle of the detector is the creation of a magnetic field by a constant power source in the core of a sensing coil. Any irregularities in the wire rope change the density of this magnetic field or flux. These defects are measured and calibrated as output signals which are in excess of a predetermined range. The sensing device, or pick-up coil, energizes appropriate electronic relays which perform desired functions of alarm sounding, such as flashing a warning light, automatic paint spraying on the product to denote the point of defection, or stopping of the operating equipment. These alarms enable the operator to take necessary action to eliminate any faulty sections of the product from the production line.

In the application of scientific quality control, the wire rope itself forms an integral component of the system as a balanced and calibrated unit of perfection. Any deviation from this controlled quality standard sets the detecting and indicating systems into action.

A permanent record of all product examinations and quality control is automatically produced during the operation of the system. This recording also serves as a continuous check of the proper operation of the detecting device.

At American Steel & Wire's Trenton, N. J. plant, wire rope is subjected to the eye of this Magnetic Flaw Detector. The finished wire rope, on its way to a shipping reel, passes through a magnetic sensing coil which is controlled by the panel shown on the left. A defect is indicated by a light signal on the panel and also by paint sprayed on the rope from the small white box shown near the exit end of the detector ring. Under the operator's hand is a recorder that maintains a written tape chart of the inspected rope's quality.

FLEXIBLE COUPLING

Lovejoy Flexible Coupling Co., offers a new radially removable flexible coupling that provides extremely easy assembly and disassembly. This unit is lubrication-free and is especially suited to centrifugal and impeller pumps and other installations where radial removability is required.

Six sizes are available, ranging from 2.58 to 29.6 hp at 100 rpm. All feature reversible cushions so that the cushions can be reversed on unidirectional loads to double their service life.

The radial removability is accomplished by special cushions cut so that they are held in position by a standard Type "C" collar when the coupling is assembled. When the collar is removed the cushions can be easily removed. This allows the coupling half and connected shaft to be rotated so that the intermeshing jaws slide into the stationary coupling half which is not removed. Disassembly is similarly accomplished.

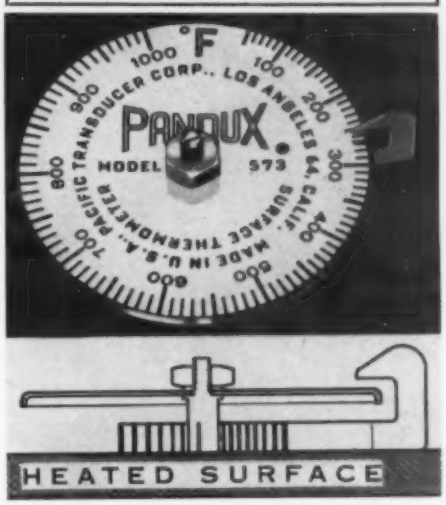
SLIDE RULE

A green-yellow slide rule that eliminates violet and red rays which focus in the front of, and behind the retina are available from Pickett & Eckel, Inc.

Due to the green-yellow shade of the rule, blurring and errors in reading calibrations, and eyestrain have been cut.

The non-corrosive, non-rusting metal construction of these slide rules eliminates warping, swelling and binding. They are available in 6 in. and 10 in. Trig, Log-Log standard rules, or in rules made to special order.

THERMOMETER



This spot check surface thermometer, made entirely of stainless steel, with a range of from 50 F to 1000 F, has been announced by Pacific Transducer Corp. The device reads temperatures of all surfaces such as heavy sheet metal, furnace skins and cooled billets. It also reads ambient temperatures in furnaces, ovens and other enclosed spaces, as well as in non-corrosive liquids and gases, up to 1000 F. Easy to read, compact and fast-operating, the thermometer comes accurately calibrated to within plus or minus two per cent and can be re-set by the user.

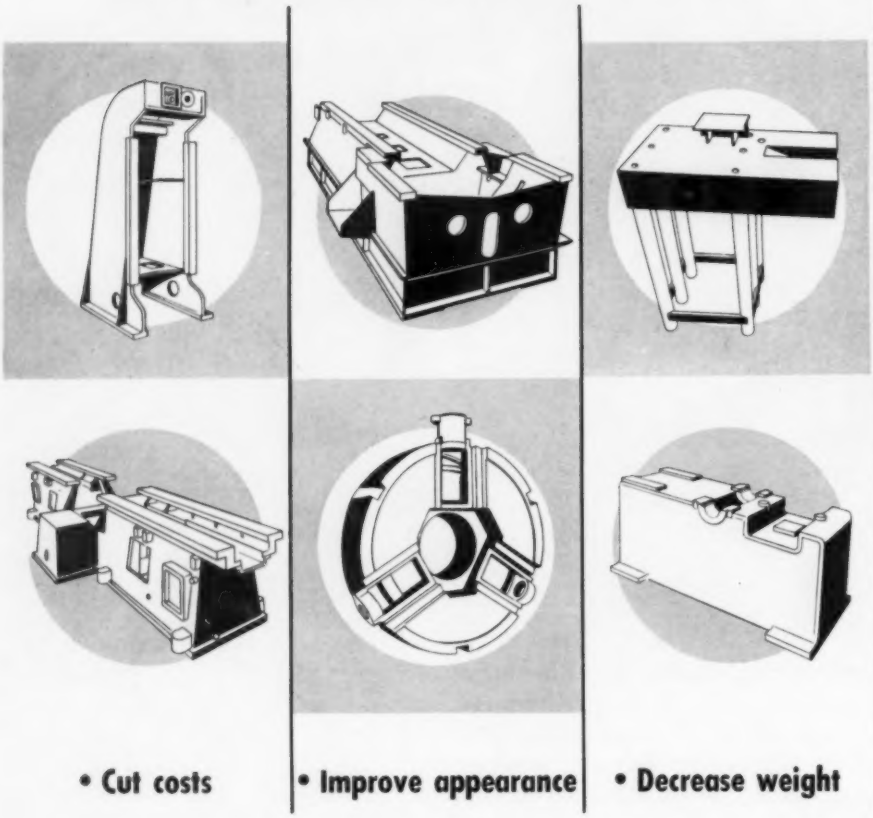
D-C UNITS

Announced by General Electric Co. is a new line of direct-current motors and generators designed for versatility of application and performance.

Known as the "Kinamatic" line, these motors and generators have speeds adjustable by armature voltage control, field strength control, or any combination of both. Higher base speeds are available and higher top speeds may be obtained by field strength adjustment. They can op-

ENTERPRISE

WELDMENTS



• Cut costs • Improve appearance • Decrease weight

Weldments can save you money —on pattern costs, reduction of metal tonnage, on shipping and handling. As designed by ENTERPRISE, they usually give you extra savings in time and labor costs, too.

Weldments can make your job look better — by reducing bulk, and by taking full advantage of the newest forming equipment. ENTERPRISE engineers know how to streamline bulky, heavy pieces—and ENTERPRISE is equipped to follow-through with speed and economy.

Lighter weight, accompanied by increased strength, is a typical weldment "bonus." It saves you money—makes expensive jobs reasonable, difficult jobs practical —and gives you an important new sales feature.

Check what ENTERPRISE Weldments can do for *You*.

Write or phone us for information or quotation on any job. Absolutely no obligation.

ESTABLISHED 1878

THE ENTERPRISE COMPANY

Columbiana, Ohio, U. S. A.

erate at any speed below base, including stalled torque.

All standard "Kinamatic" motors and generators have dripproof enclosure and are supplied with a guaranteed 15 per cent service factor. Class B insulation is supplied throughout. Significantly reduced armature inertia (WK^2) permits faster speed of response. Many new features have been incorporated into the line for easier maintenance. Smooth, streamlined design gives these motors a modern, rugged appearance. All ratings and accessories are available from one to 150 hp and ¾ to 100 kw.

Large hand holes permit easy access to commutator. If brushes need replacement, spring is easily disengaged with one hand, then hangs captive to brush holder, ready for quick engagement after new brush is in place.

CASTABLE REFRACTORIES

Developed by the Robinson Product Co., are two new castable refractories. Identified as Flint Cast 29 and 30, they are compounded with a base of highest-quality calcined material, which does not require the application of heat to harden.

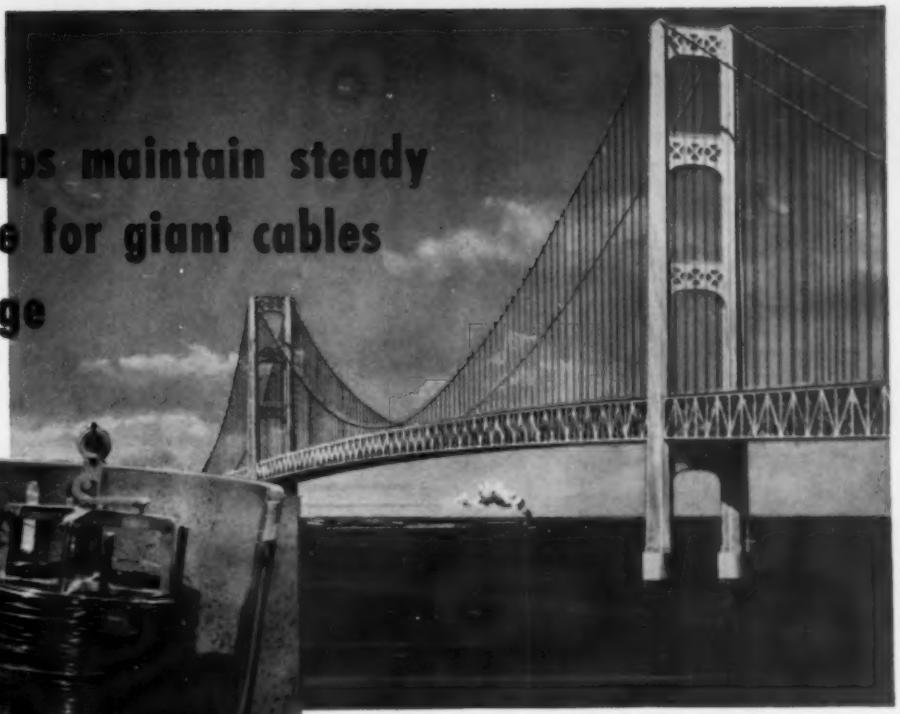
Flint Cast 29 is a high strength castable approximately twice as strong as regular castables, and is intended for forming hearths, doors and supported roofs. It also features a higher melting point and a service limit of 2900 F.

Flint Cast 30 is a medium-strength castable with a very high melting point. Intended for use at very high temperature, this castable has a service limit of 3000 F.

Both of these castables have heat stabilizers that eliminate the char-

(*Please turn to page 193*)

EC&M Control helps maintain steady production of wire for giant cables on Mackinac Bridge



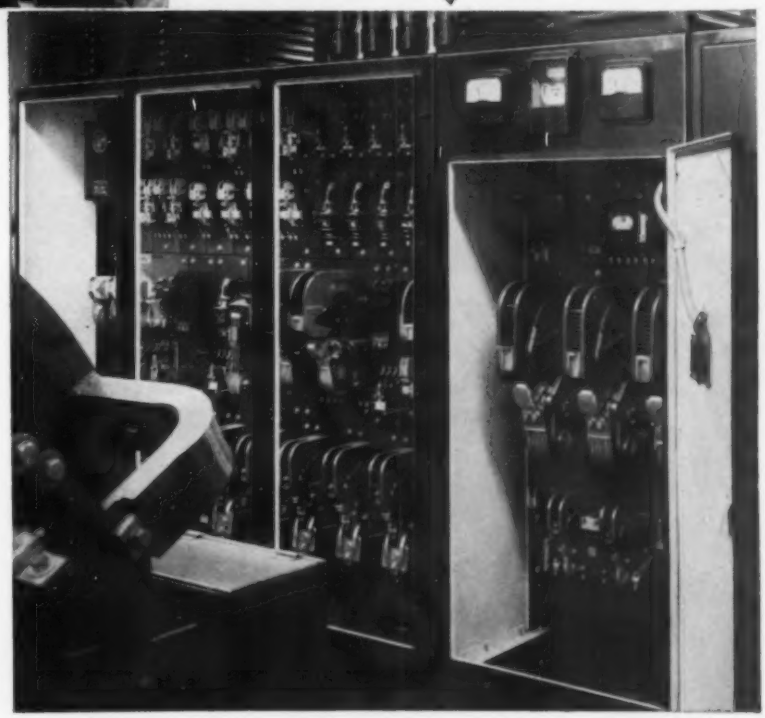
Bridge Drawing — Courtesy of Dr. D. B. Steinman, Cons. Engr. **Installation photos** — Courtesy of American Steel & Wire Division of U.S. Steel Corporation and Vaughn Machinery Co.

EC&M Wire block Controller (at left) for 60/75 HP, 500-1800 RPM, 230 Volt Motors. At right is 725 HP, 440 Volt Synchronous Motor, Starter and Circuit Breaker Panel (with door closed) for 500 KW Generator.

SMOOTH STARTS... QUICK STOPS... WIRE IS DRAWN AT SPEEDS UP TO 700 FEET PER MINUTE

Mackinac Bridge, for connecting the two peninsulas of Michigan, will soon stand as a great link in our national highway system. Scheduled for completion in 1957, EC&M Control will have played an important role in this project by helping maintain a steady flow of 0.192" diameter wire to this important project. Wire is drawn from rods to make up the 2-ft. diameter suspension bridge cables. EC&M Control, *engineered* for the task, will have helped produce millions of feet of wire before the first auto crosses this outstanding highway link.

Ability to thread at slow speed, accelerate smoothly to continuous drawing speed, and quick-stopping when the reel is finished, a snarl develops or the wire breaks, are essential to good wire-drawing. Control for wire machines is custom built to the size and number of motors per machine and to the ever-increasing production-speed that is being required. Consult with EC&M whenever wire-drawing problems arise.

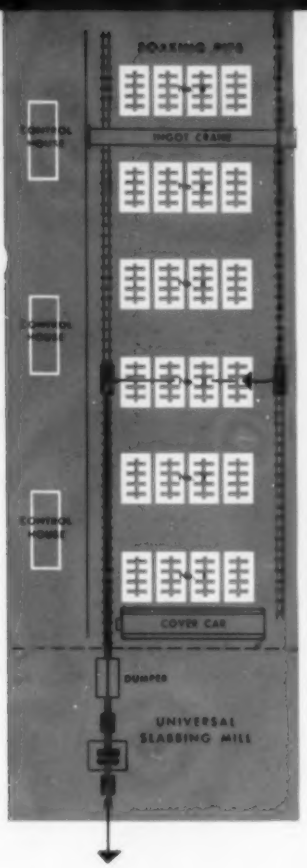


THE ELECTRIC CONTROLLER & MFG. CO.

Division of the Square D Company

4498 LEE ROAD • CLEVELAND 28, OHIO

at Great Lakes, too...



high-production soaking pits

. . . a convincing example of 'Surface' leadership. Behind the story of these 24 soaking pits at Great Lakes Steel, Detroit Division of National Steel Corporation, is an imposing record of achievement: Surface Combustion has built 80% of all new pits since World War II.

At Great Lakes, six batteries, four 'Surface' pits in each, heat low carbon steel ingots for automotive and appliance steel. They also heat some low alloy steel ("NAX" grade). Capacity will be still further increased by the addition of 16 new single 'Surface' pits now being built.

These one-way-fired pits include such 'Surface' features as the efficient jet pump recuperative system, and integrated temperature and combustion controls which are of the most modern design. The performance of these pits, and many others, is among the reasons why steelmakers depend on 'Surface.'

SURFACE COMBUSTION CORPORATION, TOLEDO, OHIO

Surface
STEEL MILL FURNACES

Foreign affiliate companies:

British Furnaces, Ltd., Chesterfield; Stein & Atkinson, Ltd., London

Stein & Roubaix, Paris, Liege, and Genoa; Chugai Ro Kogyo Kaisha, Ltd., Osaka

Benno Schilde Maschinenbau, A.G., Bad Hersfeld (Hessen, Germany)

It's in the Bag!

Fresh, Clean Ink for a Year of Trouble-free Recording

★ You won't have any messy, time-consuming re-inking of pens on the new Bailey Recorders. The entire system is white-glove clean—hermetically sealed, non-evaporating, non-corrosive. Gone is any chance of sludge or oxide formation. Gone are clogged pens, interrupted records, unsightly splashes.

The transparent plastic ink sacs are changed once a year—that's all. Capillary tubing carries fresh, clean ink to the pens continuously without any day-to-day attention.

This exclusive new inking system* is only one of the many time-saving, money-saving distinctive features of the new Bailey Recorder.

Ask for Product Specification E12-5. P34-1

*Now available for the New Bailey Recorder only.

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster ordering—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

BAILEY METER COMPANY
1047 IVANHOE ROAD
CLEVELAND 10, OHIO
Controls for Power and Process

BAILEY METERS
Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW · LEVEL
RATIO · DENSITY

(*Continued from page 188*)

acteristic strength losses of regular castables in the 1300 to 2000 F range.

Flint Cast does not expand, shrink or crack with drying or burning, and it withstands the action of flash temperatures or sudden changes in temperature without weakening.

POCKET CO DETECTOR

▲ A pencil-size carbon monoxide detector shows at a glance if, in the air being tested, carbon monoxide is present in any concentration which is dangerous for either occasional, short-time or long exposure.

The instrument is fast and simple in operation, and instantly shows the presence of carbon monoxide concentration, even as low as 40 parts CO per million parts of air. It requires no color matching or reference to a comparator scale.

MONOXOR Carbon Monoxide Detector
REPLACEABLE INDICATING TUBE CONTAINS CARBON MONOXIDE SENSITIVE CHEMICAL WHICH TURNS BROWNISH-GRAY WHEN CO PASSES THROUGH TUBE
ASPIRATOR WITH CONNECTOR FOR HOLDING THE INDICATING TUBE

The "Monoxor" Tester, announced by Bacharach Industrial Instrument Co., comprises a replaceable indicating tube and an aspirator pump with connector for holding the indicating tube during the test.

The glass indicating tube contains a yellow carbon monoxide sensitive chemical which turns brownish-gray when carbon monoxide passes through the tube.

The tube ends are sealed as supplied, and these seals are broken off when the tube is inserted into pump connector.

Air is then drawn through the tube by depressing the button in the center of the pump barrel.

After the button has returned to its original position (about six seconds) the indicating tube is examined. If the chemical shows a brownish-gray stain the CO concentration in the atmosphere tested exceeds the limit allowable for short time exposure and the area should be cleared immediately. If the chemical shows no stain a second pump stroke is taken. Appearance of a brownish-gray stain after the second stroke indicates that the air contains CO in a concentration which begins to constitute a danger to health and such a room should be occupied for only short durations. No appearance of stain after the second pump stroke is an indication that there is no hazardous concentration of carbon monoxide in the air.

BUTTERFLY VALVE

A stress-sealed butterfly valve which meets the rigorous tolerance of permissible leakage in the closed position under the difficult combination of high velocity flow and of high temperature has been developed by W. S. Rockwell Co.

The valve is 36 in. pipe size. The steel disc has a stainless steel seating edge. When it rotates to a 90 degree closed position, it seats against an

SAVE downtime for bearing replacement

use A·B·K* bearings

A-B-K bearings won't peen, score or heat check your heavy roll and spindle parts, sharply reduce downtime and maintenance costs per ton rolled. Made of laminated phenolic fabric, they have the ability to absorb and cushion heavier impacts—and often outwear metal bearings many times. When replacements *are* necessary, downtime is reduced because A-B-K bearings have fewer parts, are lighter in weight, easier to handle. Ask our engineers for specific recommendations.

- Wear longer
- Won't score
- Light in weight
- Cut lubricant costs
- Save power

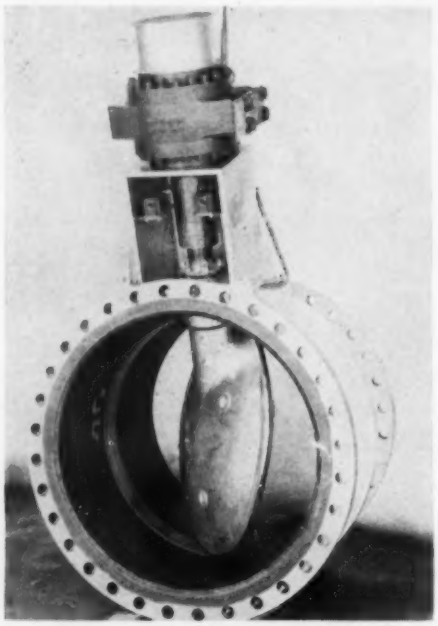
A·B·K
LAMINATED
PHENOLIC BEARINGS

*A registered trade-mark of American Brake Shoe Company in the United States and of Joseph Robb & Company, Limited, in Canada.

American Brake Shoe Company

AMERICAN BRAKEBLOK DIVISION
Detroit 9, Michigan
In Canada: Joseph Robb & Co., Ltd., Montreal, Quebec

Inconel-X band in the valve body. This band is then inflated under nitrogen pressure for tight shut-off at operating temperatures up to 800 F. The valve has been tested to



a leakage not exceeding .005 lb of air per second with a 10 lb differential across the disc.

An important factor in minimizing or eliminating leakage is the off-set shaft design, which permits full 360 degree sealing surface of the disc without the necessity of the shaft going through stress-seal band.

The valve is operated by a hydromotor driven by oil at 300 psi pressure. Limit switches indicate full open and full closed positions. In addition there is a potentiometer connection at the top of the hydromotor connecting to a valve disc proportioning device.

TUBE EXPANDER CONTROL

An all-air driven tube expander drive known as the Torq-Air-Matic has been developed by Thomas C. Wilson, Inc. This new control is entirely free from the effect of operating variables and maintenance problems, and provides a control with torque output calibrated in terms of ft-lb instead of arbitrary units of measurement.

Measuring devices on conventional expander controls measure input-output ratio only. The Torq-Air-Matic method of registering torque at the output spindle prevents tubes from being over-rolled or under-rolled. The readings are precise and consistent regardless of tube sheet hole variations. This control feature also eliminates overstressing of tube sheets, reduces warpage and ligament "push-over." Tube bowing is held to absolute minimum which increases the efficiency of heat exchange units. Tube life is increased and operator fatigue is minimized.

The control can be handled in the same manner as a conventional flue roller and will withstand the same abuse.

It will produce 14 ft-lb torque at 90 psi with maximum consumption of 12 cfm of air. It is completely self-contained, which eliminates the need of separate control cabinets, cables

Unit features pistol grip design, together with an auxiliary handle which may be swivelled to any position.

and other connections. The only connection required is the operating air hose.

This unique tool accurately controls tube expansion by directly measuring torque output at the output spindle right at the mandrel for maximum convenience and efficiency. By measuring torque at this point, all possibilities of measuring errors caused by operating variables as they affect conventional control types are eliminated. Such variables, which include motor wear, changes in the quantity and viscosity of lubricants and voltage fluctuations, do not affect this control.

HELICAL GEAR DRIVES

A completely new line of in-line helical gear drives which combine a high degree of standardization with ability to stand up in heavy duty service has been developed by Link-Belt Co.

Double reduction drives are avail-

Markal PROTECTIVE COATINGS
HEAT-PROOF TO 2100°F.
You get real protection when you brush or spray MARKAL COATING "S-R" on your stacks . . . protection against corrosion, scaling and oxidation at temperatures high as 2100°F.
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MARKAL COMPANY • 3087 West Carroll Avenue • Chicago 12, Illinois

Expansion tests show why you get SUPERIOR END WALL SERVICE with Kaiser Periclase-Chrome Brick

ONE REASON why Kaiser Periclase-Chrome Brick assures better end wall service for many leading steel producers is shown by this laboratory test of the effect of steel plates on permanent growth.

In this test, pre-fired 9x4½x3" bricks of two types were compared: brick having a chrome-magnesite ratio of approximately 75 to 25, and Kaiser Periclase-Chrome Brick.

Both types of brick were laid up as headers, forming the side walls of a tangentially fired pot furnace. 16-gauge steel plates were applied to the four sides of the bricks. The bricks were set loosely, with only 4 courses of brick overlaying the test pieces.

The effects produced in the laboratory were the result *solely of the heating and iron oxide reaction*. Heating and atmosphere conditions were identical on each type of brick. The furnace was heated with gas to 3100°F. ± 25°, and held at this temperature for 16 hours. Heating and cooling was at the rate of 75°F. per hour to minimize thermal spalling effects.

Results of the test

After cooling, the bricks were separated and photographed. (See picture.) Note strings stretched from top corners of new brick on ends of each row. Comparative growth on hot faces of brick shows above strings. The upper row of brick is the chrome-magnesite type. The maximum linear cold expansion of these bricks was 1" or 11%, with an average of 9%.

The lower row of bricks are Kaiser Periclase-Chrome. The maximum linear cold expansion of the Kaiser brick was only $\frac{3}{16}$" or 2.1%, with an average of only 1.4%.

These values are in addition to the reversible thermal expansion, in each case.

Also, note in the picture the cracking of the chrome-magnesite type brick caused by the relatively great iron-oxide swelling. The Kaiser Periclase-Chrome Brick is free from such cracks.

The superiority of Kaiser Periclase-Chrome Brick

This test indicates only one of many reasons why Kaiser Periclase-Chrome Brick gives hearth operators better end wall service.

The special composition of Kaiser Periclase-Chrome Brick assures less spalling, less swelling, greater resistance to abrasion and alteration by oxide and slag. This superior brick can greatly increase end wall life or greatly reduce wall thickness to cut costs, when end wall service is balanced.

Call or write any of the sales offices listed below for immediate attention to your end wall particular problems.

Call or write Kaiser Chemicals Division, *Kaiser Aluminum & Chemical Sales, Inc. Regional Sales Offices: 1924 Broadway,* OAKLAND *12, Calif. . . . 3 Gateway Center,* PITTSBURGH, *Pa. . . . 518 Calumet Building, 5231 Hohman Ave., Hammond, Indiana* (CHICAGO).

Kaiser Chemicals

Pioneers in Modern Basic Refractories

REFRACTORY BRICK • RAMMING MATERIALS • CASTABLES & MORTARS • MAGNESITE • PERICLASE • DEADBURNED DOLOMITE

Kaiser PERICLASE Brick for the Steel Industry:

- Periclase Brick (D-S)
- Periclase Chrome Brick
- Chrome Periclase Brick

How can you afford ordinary gear type couplings when AJAX NEW 3-D Degree DIHEDRALS HANDLE 3 DEGREE MISALIGNMENT at the same low price?

With ability to handle angular and offset misalignment...with minimum backlash... with perfected lubricant sealing...with long life,—Ajax Dihedral Couplings have made ordinary couplings obsolete.

And now AJAX adds this new 3-D Self-aligning Dihedral Coupling at prices competitive with ordinary gear type couplings.

Features of the new Ajax 3-D Dihedral Coupling include:

3 degree misalignment capacity.

Load is distributed at center of teeth at the point of greatest strength.

More tooth strength is provided under misalignment than is possible with any other tooth shape.

Exclusive Ajax Dihedral tooth design has less clearance than conventional gear type couplings.

No end-of-tooth wear under misalignment. Johns-Manville "Clipper" seals keep lubricant in and foreign matter out.

Compact overall size.

Designed for NEMA motors with standard keys.

Low prices competitive with ordinary gear type couplings.

AVAILABLE IN 5 SIZES

Write for new Catalog No. 60

Cut-away view of Ajax 3-D Dihedral Self-aligning Coupling showing arrangement of specially designed gears and location of lubrication seals.

Patented or Patents Pending in U. S. A. and foreign countries.

AJAX FLEXIBLE COUPLING CO. INC. **WESTFIELD, N. Y.**

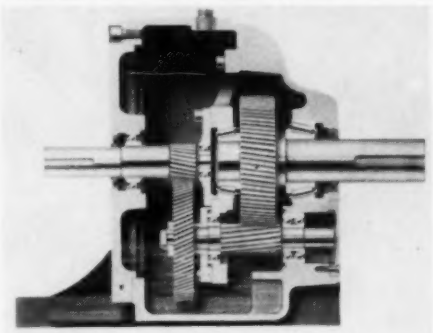
Representatives in Principal Cities

The World's Most Complete Line of Flexible Couplings

able in ratios from 6.2 to 1 through 38.4 to 1, with capacities up to 118 hp. Triple reduction drives are available in ratios from 47.1 to 1 through 292 to 1, with capacities up to 20 hp.

One-piece cast iron housings, with reliable oil seals at shaft openings, prevent oil leakage. The cast iron construction has inherent sound deadening properties.

Space requirements and layout problems are minimized by locating input and output shafts in the same horizontal and vertical planes.



Precision gearing is assured through the use of hardened gears that are produced on modern hobbers and then shaved. Close tolerances are guarded by continuous inspections through every phase of production. All moving parts are splash lubricated and permanently aligned.

The pinion is straddle-mounted to provide the strength needed to cope with shock, reversing or heavy loads.

Maintenance is simplified through maximum accessibility and the fact that it is unnecessary to change the low-gear set in order to alter the ratio.

The design of all drives permits the addition of an integral positive-locking backstop at any time without modifications.

SHAFT COLLAR

▲ Available from Climax Metal Products Co. is a new line of shaft collars available in 44 bore sizes from $\frac{3}{16}$ in. to three in. in $\frac{1}{16}$ in. increments. The collars, equipped with precision, cup-point socket set-screws, are designed to hold shafts mounted on plain bearings in position, eliminating "floating."

The collars, in sizes up to two in., are machined from cold rolled steel with cadmium finish. The larger sizes are machined from cast iron with machinery gray lacquer finish. All

USS

FAIRLESS WORKS uses DIAMOND INDUSTRIAL TV to Improve Operation and Cut Costs

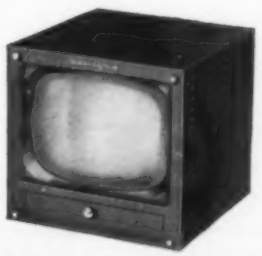
Arrow points to Diamond ITV camera (in protective housing) used to watch slab positioning.

Operator at pulpit SEES on the Diamond ITV screens when slabs are in correct position for charging two end furnaces.

Four slab reheating furnaces are charged by one operator using Diamond ITV at Fairless Works of the U. S. Steel Corp. Slabs are aligned properly eliminating danger of serious damage to furnaces. Operating costs are reduced.

You, too, probably can use Diamond ITV to substantial advantage. For case histories and suggestions, get in touch with your Graybar Distributor or use the coupon below.

Camera



Monitor

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"FIRST IN INDUSTRIAL TELEVISION"
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Please send me without obligation a copy of new bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs, improve quality, increase sales and aid safety.

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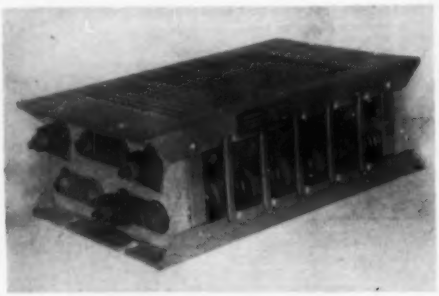
Engineered and designed to eliminate resistor maintenance on troublesome mill applications.

Non-breakable helical coil construction ends burnouts due to warping and buckling of grids.

Sturdy, rugged steel construction eliminates shock and vibration troubles.

Custom designed for your conditions including excessive graphite accumulations.



With a quarter century of resistor engineering, we invite you to take advantage of our experience.

For complete information on Guyan Resistors, please contact the nearby Guyan Representative or our main plant at Logan, W. Va.

Baltimore, Md.—Durling Electric Co., 2505 St. Paul St.

Birmingham, Ala.—Ebbert & Kirkman Co., 2313 6th Ave. So.

Buffalo, N.Y.—Buffalo Electric Co. West Mohawk St.

Chicago, Ill.—John K. Byrne, 1515 W. Howard St.

Cleveland, Ohio—Mechanical Equipment Co. 3100 Prospect Ave.

Detroit, Mich.—Plant Equipment Co., General Motors Bldg.

Philadelphia, Pa.—George I. Wright 811 Commercial Trust Bldg.

Pittsburgh 27, Pa.—P. R. Holden, 4860 Elmwood Dr.

GUYAN MACHINERY COMPANY

LOGAN, W. VA.

collars are machined with chamfered inside and outside corners and are precision bored to assure trouble-free service. For convenience, collars are shipped with set-screws assembled.

The collars are uniformly packaged in 5 to 50-piece quantities, depending upon size, and are clearly labeled for stocking convenience.

CRANE CONTROL

Developed by Femco, Inc., is an electronic system to provide remote control of traveling cranes from the plant floor.

No additional power rails are required as carrier current over existing power rails is the only circuit required. Installation is simple for any crane or similar device now in use or in new construction. With the new control, an operator can raise or lower the hoist (5 positions), position the trolley forward or reverse (5 positions), travel forward or reverse (3 positions) and can energize or turn off the magnet, all from the floor.

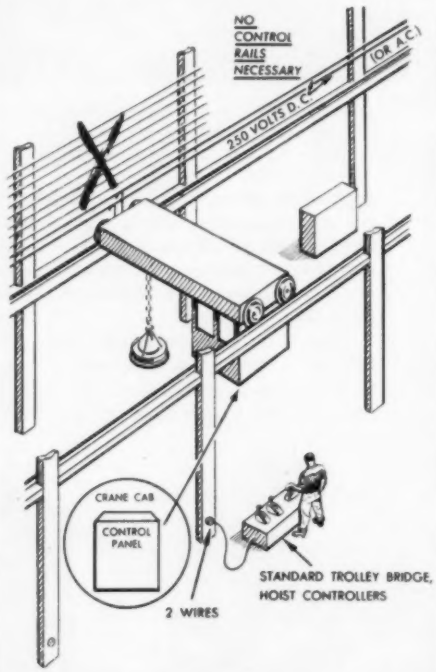
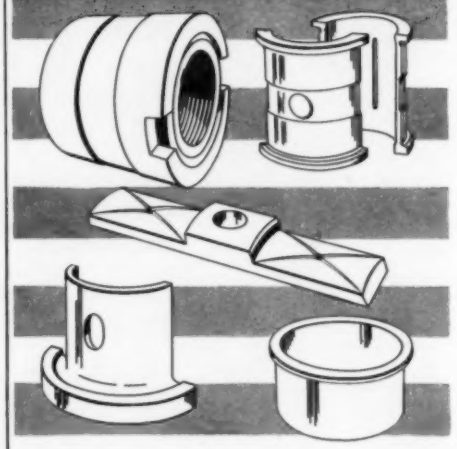


Diagram shows simplicity of installation and operation of new crane control.

As many as eight cranes can be controlled on one power circuit by use of different carrier frequencies and one operator can operate more than one crane. By use of two control panels, a crane can be loaded by one man and then sent to the other end of its runway where another man can unload it and send it back.

FLOOD CITY
for the best
BRONZE PARTS



Flood City Bronze Parts are best . . . best fitting . . . best wearing . . . all expertly machined from the best grade of hard, wear-resistant bronze or to your particular specification bronze.

For years Flood City has furnished quality bronze parts at a savings in metal weight and machining costs to a variety of industries.

We welcome your inquiries concerning quotations and delivery on your bronze parts needs. Our reply will be prompt —and there is no obligation.

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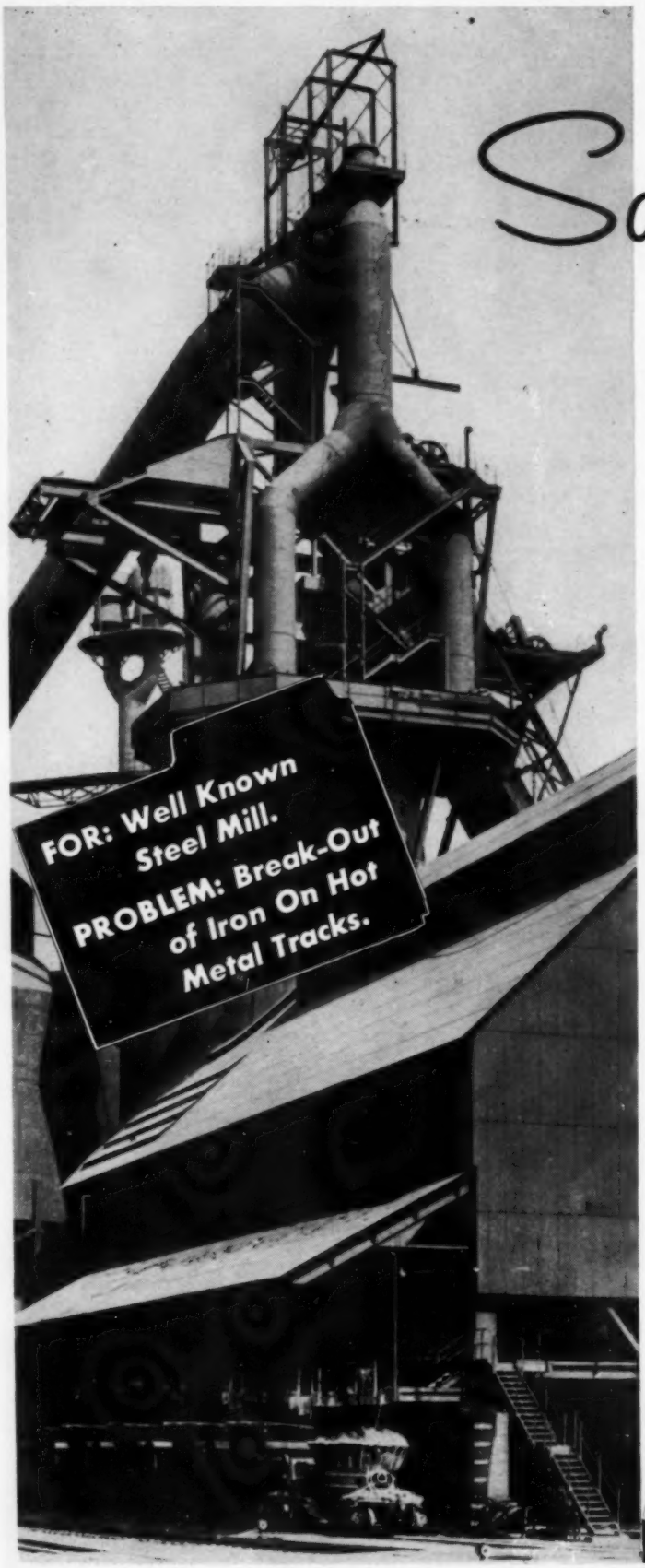
CHICAGO CONCRETE ON THE JOB IN 2 HOURS



Saved

40 HOURS OF PRODUCTION

"WE THOUGHT OUR FURNACE WOULD BE OUT OF PRODUCTION AT LEAST 2 DAYS . . . BUT WITHIN TWO HOURS AFTER THE BREAK-OUT CHICAGO CONCRETE WAS ON THE JOB . . . AND IN 24 HOURS WE WERE BACK IN FULL PRODUCTION," so commented the superintendent of blast furnaces at a well-known steel mill. It is another story typical of the speed that CHICAGO CONCRETE is capable of — speed that has saved customers thousands of dollars. This is the story:

At 11 P.M. we received an emergency call . . . a breakout of iron on the hot metal tracks had burned up the tracks and welded a number of railroad trucks to them. By 1 A.M. the first CHICAGO CONCRETE men were on the job. In 8 hours they had the spill cleaned up and new tracks laid. Four sets of railroad trucks were saved from the scrap-heap by the careful use of dynamite . . . a service that CHICAGO CONCRETE are experts at.

On the job faster . . . with experienced skilled personnel . . . employing the most modern equipment . . . that is CHICAGO CONCRETE'S story. You, too, can depend on CHICAGO CONCRETE in any emergency.

CHICAGO CONCRETE BREAKING CO.

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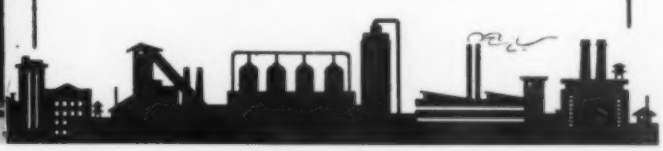
AND NOW

CHICAGO CONCRETE CONSTRUCTION COMPANY offers a complete industrial construction service . . . handling anything from minor masonry, steel or foundation repairs to complete furnace rebuilds.



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. . . for such operations as roll cooling on hot and cold mills • descaling • runout table cooling • pickling line • cooling slabs on transfer table • cooling ingot molds • cooling open hearth tunnels or checkers • cooling pigs • coke chemical processing • spraying lubricants • and air and gas washing

For every spraying operation, you will find Spraying Systems spray nozzles offer impressive, measurable advantages. That is why so many mills today specify Spraying Systems spray nozzles for every application. Made in a very wide range of types and sizes to provide exact performance to meet your requirements. To improve operations where spraying is involved, try Spraying Systems spray nozzles . . . . the engineered products of America's leading designer and manufacturer of spray nozzles for industry. Your inquiry is cordially invited.

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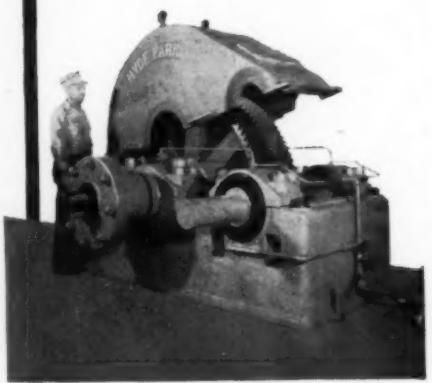
RED CIRCLE Rolls ALLOY-CHILLED

Gray Iron Castings

Hyde Park Castings up to 80,000 pounds are sound, accurate and physically dependable.
Precision machining is done by skilled craftsmen in our modern machine shop.
Send your blue prints for quotation.



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For finer finish, long life and greater tonnage, specify Red Circle Rolls.

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ROLLS
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GREY IRON CASTINGS

In operation, high-speed synchronous relays on crane and floor panel operate whenever levers are moved. Carrier frequency on each step is shifted down to a lower frequency for an "off" control and up to a higher frequency for an "on" control. Whatever control is sent during one operating cycle is stored by a "sealing-in" relay until changed by another operating cycle. The small relays which operate in a few milliseconds are repeated by contactor type relays for the actual control. An emergency stop switch is provided to cut off the carrier and open the control contactors if the relay system or carrier link should fail at any time.

The floor control panel may be in a permanent location or may be placed on a cart for portability from one to another power receptacle. All equipment is compact, ruggedly built and dirt proof.

COIL-LIFTING MAGNET

▲ An ultra-light-weight coil-lifting magnet is announced by the Ohio Electric Mfg. Co.

According to the manufacturer, the unusual "open frame" design permits steel coils to be lifted without removing the spindle on which the coils are wound. This design also cuts deadweight to a minimum. The unit weighs 2000 lb, and has a lifting capacity of approximately 5 tons and handles coils of strip steel up to 42 in. in diameter. Other diameters and lifting capacities are available. The three-pole coil-handling magnet is designed for operation on 230 volts d-c; other voltages supplied on special order.

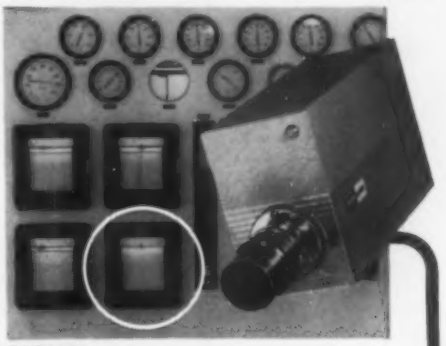
The three lifting coils are made of heavy duty copper wire with glass insulation and provide proper ampere turns for full magnetization at all operating temperatures. The special non-remelting filling compound prevents moisture penetration and short circuits, and also prevents spoilage of the strip steel. This filling compound dissipates heat rapidly to assure maximum magnet performance over extended periods.

FAULT FINDER

▲ Available from Westinghouse Electric Corp. is a fault finder that monitors control circuits continu-

(*Please turn to page 218*)

KAY LAB
CLOSED CIRCUIT TV PIONEERS



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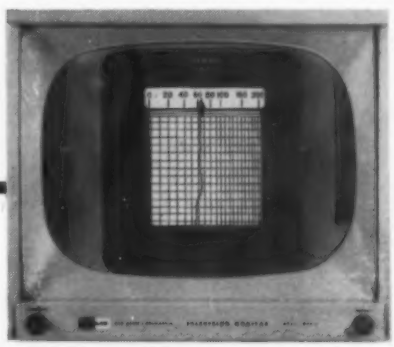

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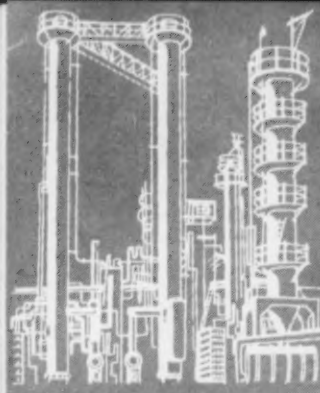
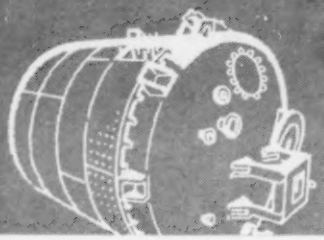


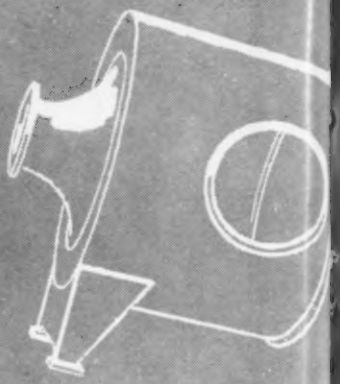
McGREGOR-MICHIGAN corporation

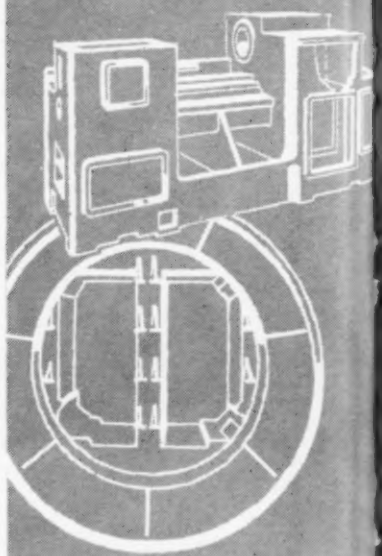


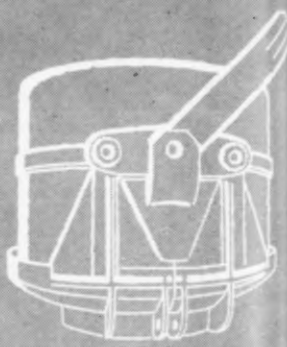
a new name FOR AN old service

A century is a long, long time. Yet for well over 100 years we have supplied industry with heavy steel plate fabrications. Originally this included power plant boiler construction and maintenance, so our old name, Central Boiler & Mfg. Co., was once appropriate. But for many years that name put us in a niche which we had outgrown. We have not *built* a boiler in scores of years, while we have constructed steel mill equipment, chemical and petroleum processing equipment, machine bases, diesel engine beds, heat exchangers, stacks and other mild and stainless steel plate fabrications. Our steel plate warehousing service is growing; power plant maintenance still remains a valuable part of our business, but we can't be "typed" by our name.

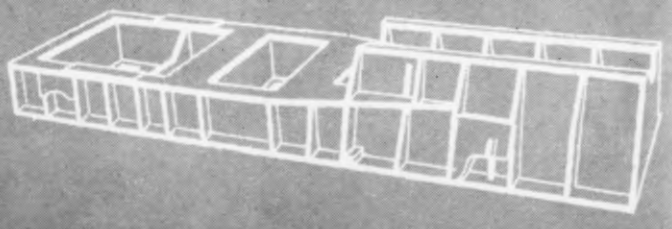
The fourth generation of McGregors has directed the Corporation for ten years. It has grown in size and versatility. Our heavy bending, forming, cutting and joining equipment is the newest and best. Some of it is especially designed and built by us to do jobs only a few fabricators are able or willing to tackle. The McGregor policy is one of uninterrupted progress, the combining of better thinking and better tools in order to produce the more durable, more efficient equipment your problem requires. It's a policy which leads to diversification of services, to customer satisfaction and, inevitably, to growth. We're confident you'll hear our name occasionally in the future—and we hope that your future and ours cross frequently.







For a detailed description of some of our activities, send for our 8-page illustrated brochure.



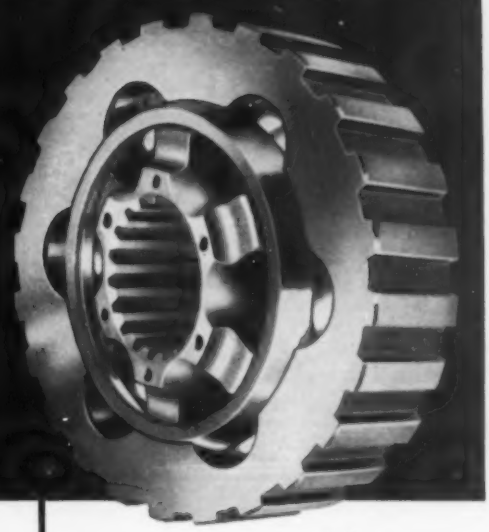
McGREGOR–MICHIGAN CORPORATION

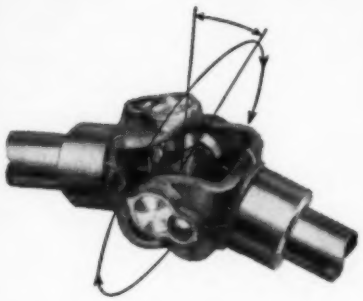
5820 RIVARD ST. • DETROIT 11, MICHIGAN • TRINITY 2-2400

HEAVY STEEL PLATE FABRICATION AND WAREHOUSING

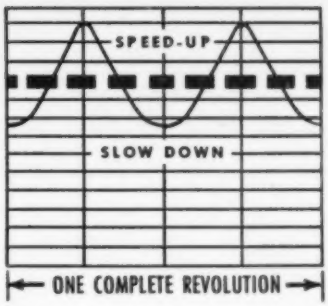
FACTS...

on a Universal Joint that cuts costs, increases production in steel-making equipment

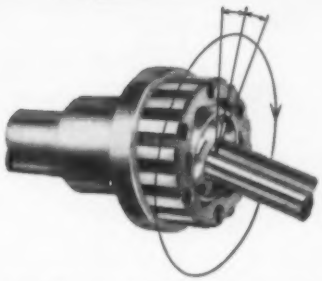




During rotation at a given angle, pin- or slipper-type joint speeds up, slows down twice during one revolution.



Solid line shows speed variation for one revolution of pin- or slipper-type joint at a critical angle. Note constant velocity of 100% for Rzeppa Joint (dotted line).



Due to its construction features, the Rzeppa Joint always transmits a smooth flow of power even at unbalanced angles. The standard joint cannot meet this test without involved compensating measures.

IN THESE TYPICAL APPLICATIONS

Among the many applications where Rzeppa Constant Velocity Universal Joints are ideally suited are:

- Blooming Mills
- Billet Mills
- Merchant Mills
- Skelp Mills
- Butt Weld Pipe Mills
- Electric Weld Tube Mills
- Hot Strip Mills
- Cold Reduction Mills
- Auxiliary Equipment

The above facts prove why you can expect superior performance when your steel-making equipment utilizes Rzeppa Constant Velocity Universal Joints. Rzeppa's *modern design* offers you all these advantages:

- INCREASED SPEEDS
- REDUCED DOWN-TIME
- LOWER MAINTENANCE
- HIGHER CAPACITIES

The next time you are considering universal joints for replacement or original equipment—why not look into the exclusive features offered only by Rzeppa.

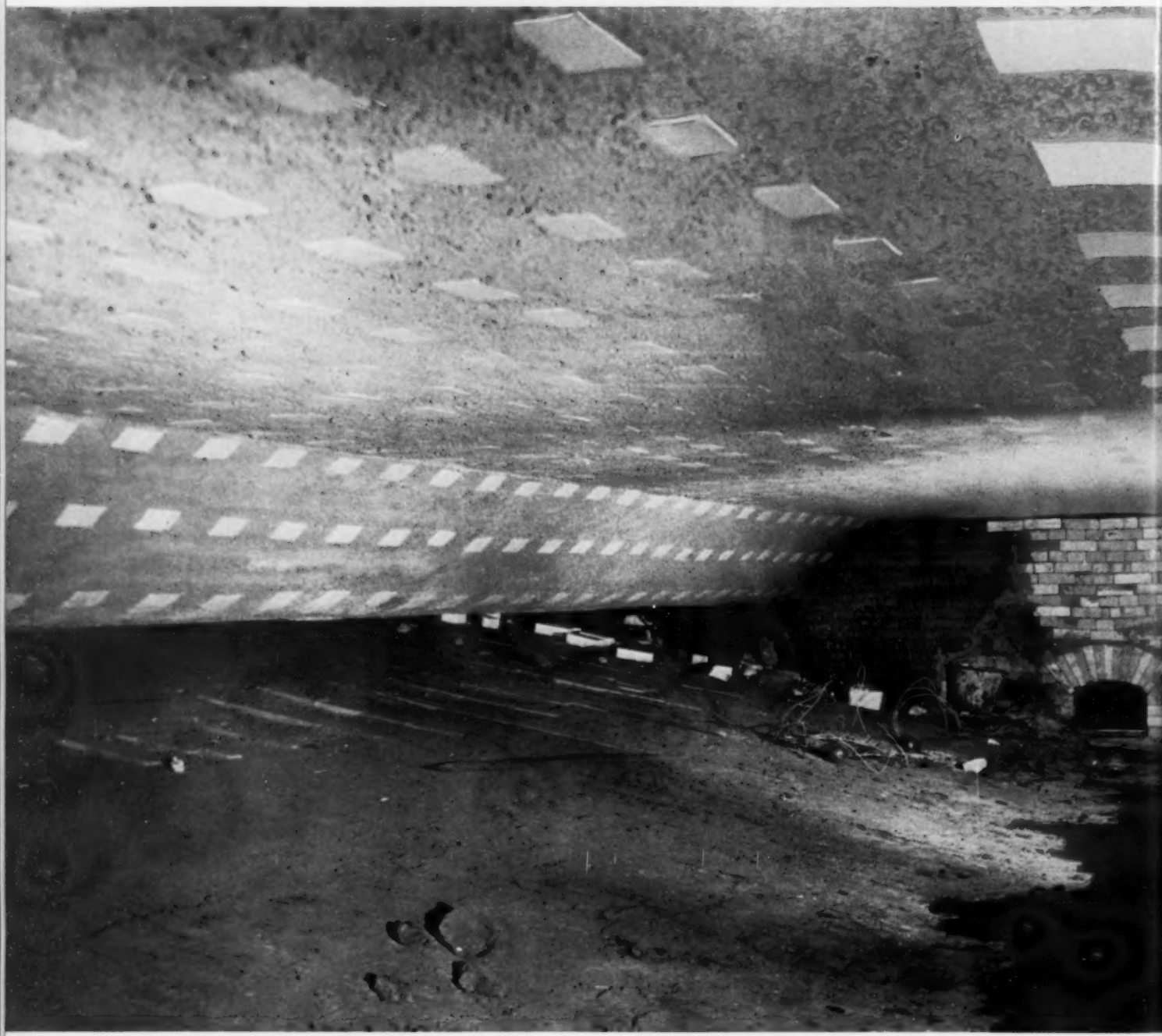
WRITE TODAY . . . for this complete brochure which offers you many more FACTS on Rzeppa Constant Velocity Universal Joints.

RZEPPA

("SHEPPA")
CONSTANT VELOCITY UNIVERSAL JOINTS

THE GEAR GRINDING MACHINE COMPANY
3929 CHRISTOPHER, DETROIT 11, MICHIGAN
Manufacturers of: Fully Automatic Gear Grinding Machines • THE DETROIT SCREWMATIC 750

RAMTITE REDUCES REFRACTORY COST



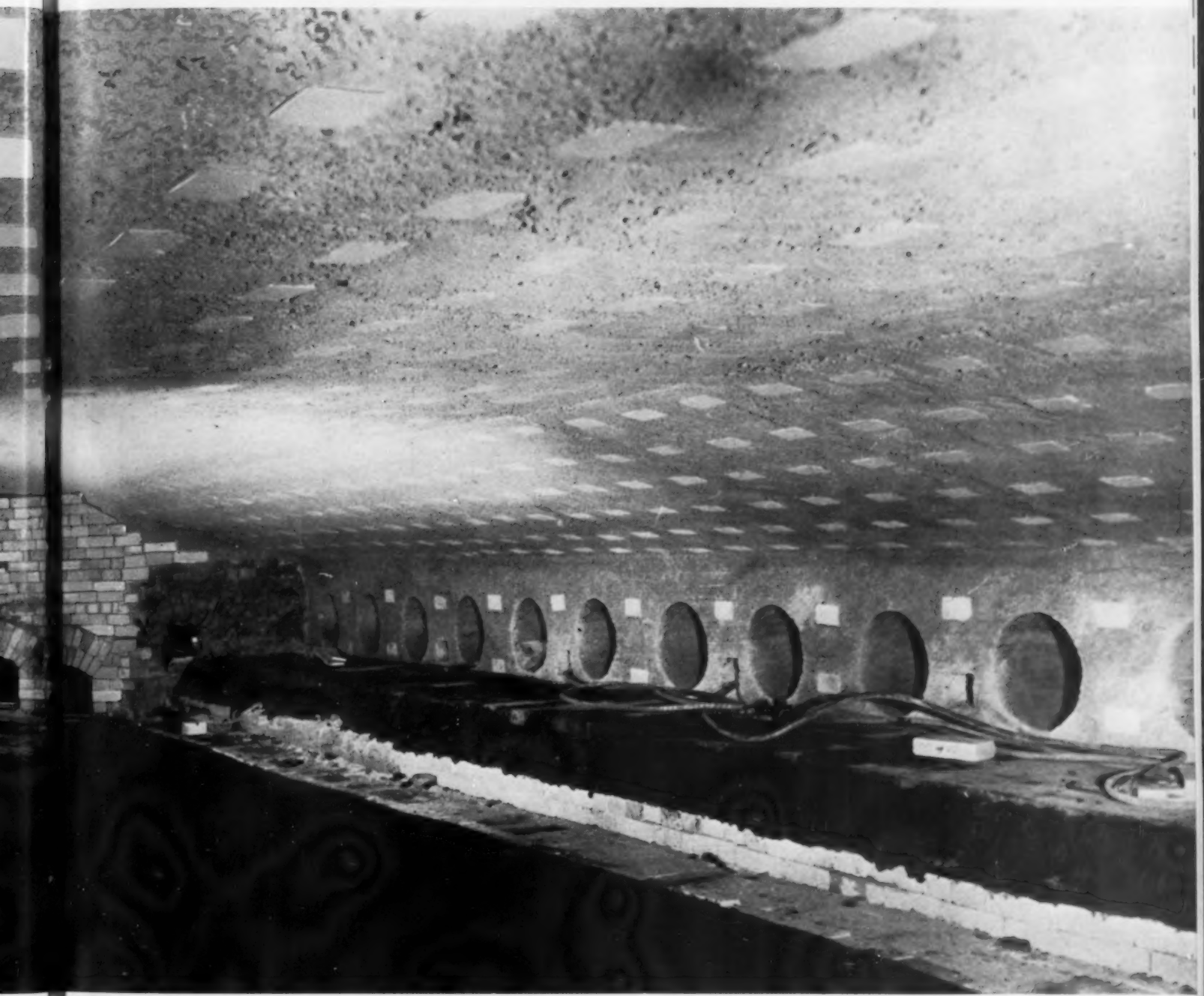
RAMTITE Burner Walls, 36'8" long by 36" high

Pan-o-Ramtite

Manufacturers of: PLASTICS—CASTABLE—GUNNING REFRACTORIES

RAMTITE is Our Business, Not Our Sideline

IN A ROD MILL FURNACE



— RAMTITE Roof 25'8" long by 36'8" wide.

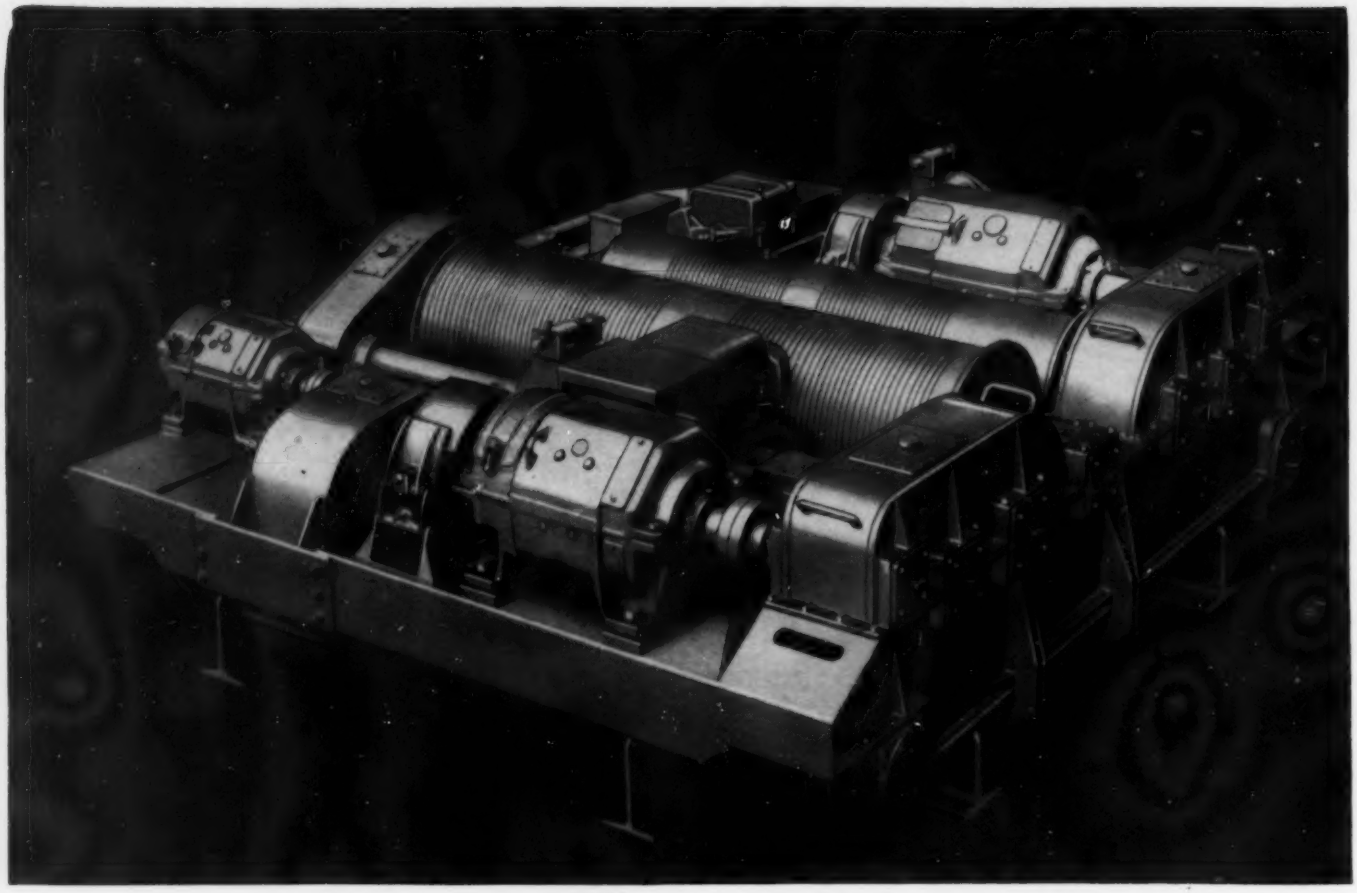
INSTALLATION — at the Keystone Steel and Wire Company, Peoria, Illinois. Before Ramtite was installed in July, 1951, previous refractories used required major repairs twice a year. Three years after Ramtite was installed, a Ramtite patch 3' x 10' was made in the roof at the knuckle. This is the only repair to date.

THE Ramtite CO.
Division of the S. Obermayer Co.
1813 South Rockwell Street, Chicago 8, Illinois

PLEASE SEND ITEMS CHECKED:
- ☐ Bulletin on Castable and Gunning Refractories
- ☐ Steel Plant Catalog

Company Name _____
Attn. Mr. _____ Title _____
Address _____
City _____ Zone _____ State _____

Can You Afford Not to Use RAMTITE?



VICTOR R. BROWNING *Trolleys*

FOR HEAVY DUTY MILL TYPE CRANES

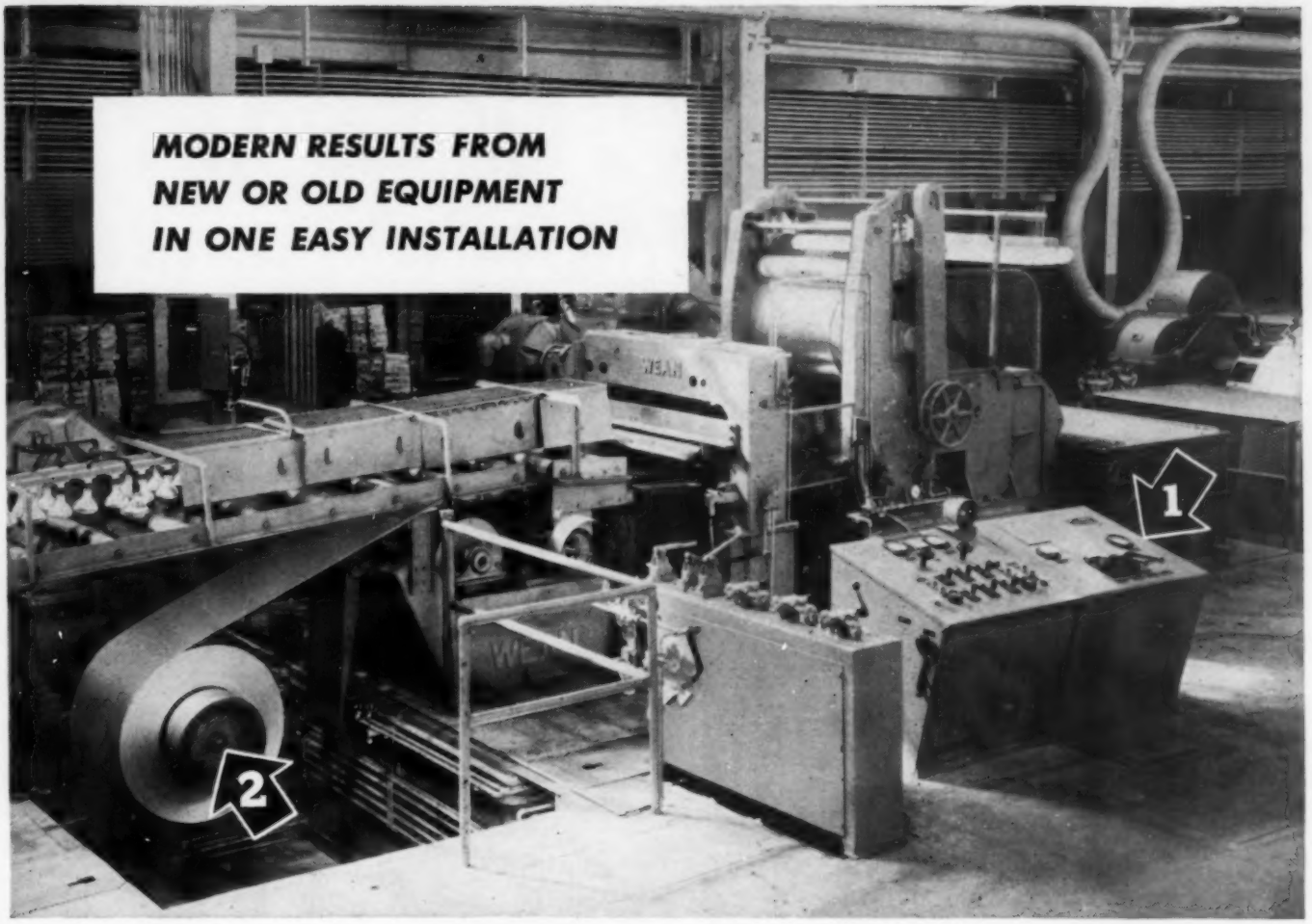
"Simple Design is Sound Design"

We offer a complete line of trolleys built to meet the most exacting requirements. These trolleys are constructed of the finest materials available. No cast iron is used. All shafts are of highest quality alloy steel. All bearings are calculated with a proper life factor for service required as defined by the A.I.S.E. We will build a trolley to fit your special requirements as to gauge, head room, approaches and general arrangement. We also make a complete line of cranes for steel mill use. . . Your inquiries will be welcome.

VICTOR R. BROWNING & COMPANY, Inc.

BOX 309, WILLOUGHBY (CLEVELAND), OHIO

Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes



FOR:

SLITTING
CLEANING
SHEARING
REWINDING

WHEELING STEEL
OPERATION TYPICAL

The Wheeling Corp. uses Askania Edge Position Control for its continuous galvanizing line...considers its function of utmost importance to volume production operations. In the above photo the Askania Edge Position Control (#1) insures straight coil (#2).

WHAT IS YOUR
POSITIONING PROBLEM?

Here's a control that can be applied to *any* material of *any* size or weight in *any* plant operating at *any* rate of speed.

Send for Bulletin No. 161 for complete information. Write Askania Regulator Company, 246 East Ontario Street, Chicago, Ill.

ASKANIA Edge Position Control Quickly Adapted To ANY Existing Reel Operating At ANY Speed

Continuous and accurate line production need not be confined to new production equipment. The ASKANIA Edge Position Control is applied to most new steel production lines and is also easily adaptable to existing lines without major expense. If your existing reels now have manual control of lateral movement, Automatic Edge Position Control is easily applied. Automatic Control can be used on any size coil, will operate accurately at any rate of speed. It can also be applied to any marking device or tool that is to be positioned with respect to a moving edge.

NO CONTACT
AIR JET CONTROL

This basic production tool has proved its accuracy and dependability in major steel plants for years. Because no contact is ever made with steel...because the powerful hydraulic action is controlled only by a gentle jet of air... because there are no electronic tubes to burn out and require replacement... maintenance is extremely simple. Not only can you INSTALL IT YOURSELF—but the Askania Edge Position Control can be applied to almost any equipment despite extreme physical limitations which may be imposed.

HOW IT WORKS

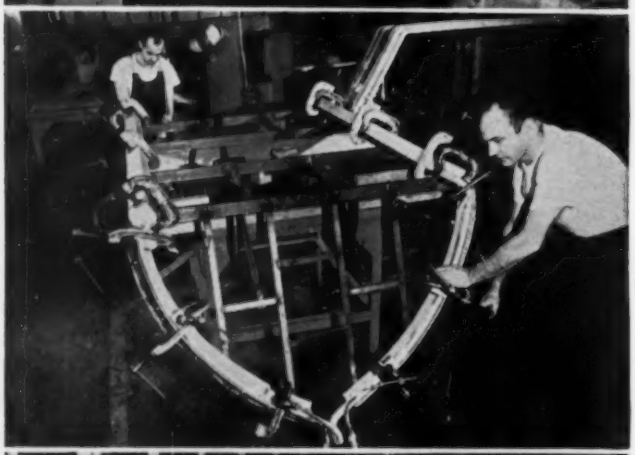
The control consists of a sensing nozzle, a jet pipe regulator and a hydraulic work cylinder: (1) The sensing nozzle measures strip error of less than five thousandth of an inch. (2) The jet pipe regulator converts a small jet of air into a *high level* hydraulic force. (3) The work cylinder applies that force to the strip under control. You'll want further information on Askania's exclusive JET PIPE PRINCIPLE which greatly simplifies the control of production line throughout industry.

ASKANIA REGULATOR COMPANY

HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

CONTROLS FOR INDUSTRY

A Subsidiary of General Precision Equipment Corporation



The three photos above were taken recently in our plant during production on an emergency schedule of a set of stator coils for a large turbo generator. Despite the large size of the machine, a complete set of 54 coils (each weighing 130 lbs.) was ready to ship 24 working days after the order was received. While coils were being manufactured, a crew had completed restacking the burnt-out laminations on the stator. Coil installation and testing required only 14 working days and the generator was back at work. Complete details on this job available on request.

Why you can count on National for fast rewinding service:

- a large staff of skilled engineering specialists
- wide experience with all types of large rotating electrical equipment, including that of foreign manufacture
- a wire mill and an extensive stock of raw copper for on-the-spot wire production as it is needed
- a complete department for the fabrication of all necessary insulating materials
- specialized tools and equipment for every operation
- a large crew of skilled workmen for coil production and installation
- highly competent field engineers for on-the-job supervision of coil installation — anywhere in the world.
- a willingness to work around the clock, if necessary, until your out-of-service equipment is back at work

Don't wait until an emergency arises to get acquainted with National facilities and services. Write today for the complete story.

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

HEAT MORE STEEL with MORGAN-ISLEY

The Morgan-Isley system offers you a better means of heating ingots with straight blast furnace gas, coke oven gas, natural gas or oil.

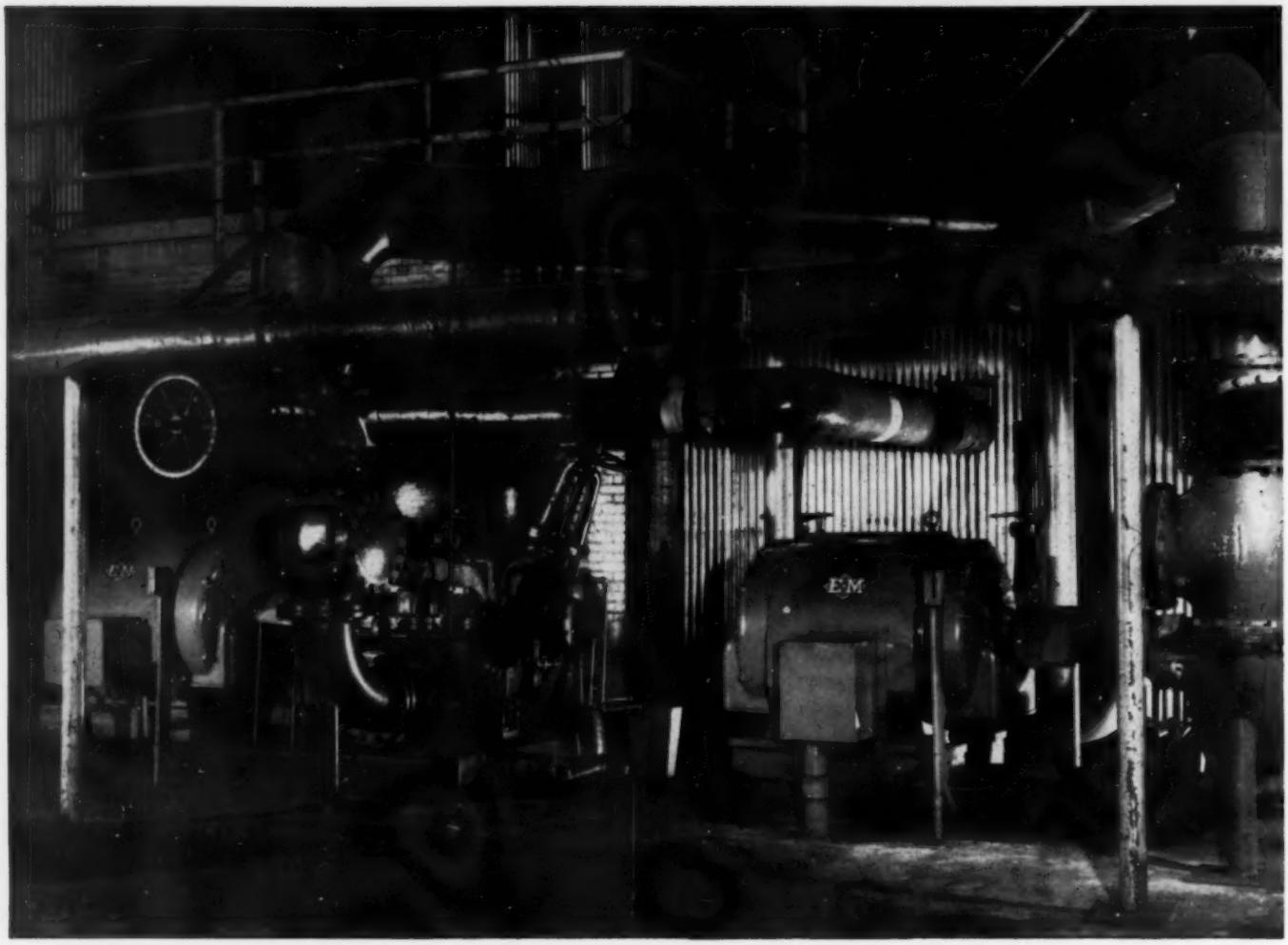
The schematic shows the flow of combustion air and flue gases through the regenerators and soaking pit. The Morgan-Isley system employs vertical regenerators. It eliminates regenerator capacity under the crane runway thus freeing this valuable area for heating steel.

CCC-49

MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

ROLLING MILLS • MORGOIL BEARINGS • REGENERATIVE FURNACE CONTROLS • EJECTORS • PRODUCER GAS MACHINES

H. H. Wood, Rep., Koppers Bldg., Pittsburgh, Pa. *English Rep.*, International Construction Co., 56 Kingsway, London W. C. 2, Eng.



Jones & Laughlin Steel Corporation enjoys low maintenance costs on large motor drives

● Safeguarding motor operation in a steel mill is an important factor in the mill's over-all profitable operation. Motor shut down means costly maintenance projects and large production losses. Bearing failures and winding burn outs are no longer considered inevitable, and today's mill operators who are interested in continuous high-level production are taking advantage of modern motor design to insure against motor failure.

The two 400 hp, 1450 rpm, splash-proof E-M Squirrel-Cage Induction Motors above show how Jones & Laughlin Steel Corporation engineers use modern motor design to protect against motor outage. These motors, which drive centrifugal pumps supplying water to three hot strip-mill furnaces at the Pittsburgh works, have given year-in, year-out service with only routine bearing lubrication and inspection. E-M *Protective Construction* keeps water and foreign material out of vital parts, so essential to uninterrupted, trouble-free operation.

And remember, *Protective Construction* means more than physical shielding of windings and bearings with splash-proof or other protective enclosures. It includes the E-M "know-how" of motor design and special attention to the smallest details of construction. Here are some of the important features in E-M *Protective Construction:*

1. Windings custom designed for the application, repeatedly processed to keep moisture out.
2. Coil ends methodically lashed to heavy rings to prevent movement during repeated starting surges.
3. Bearings precision engineered and processed for cool, long-life service.
4. And rotors of practically indestructible cage construction, accurately balanced for vibration-free operation.

For your next *special* motor application call on your local E-M sales engineer for helpful counsel. Let him show you how E-M *Protective Construction* can help keep your maintenance costs low on large motor drives. And write the factory for E-M Foto-Facts No. 16, showing other modern motor applications in a modern steel mill.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

E-M

1300-TPA-2167

Specialists in making motors do **EXACTLY WHAT YOU WANT THEM TO**

Rolls with miracle coating

FOR SKIN PASS MILLS

IN ELECTROLYTIC, GALVANIZING, SILICON, STAINLESS, ETC.

THE ALL PURPOSE ROLLS

*SPEC

PLASTIC COATED ROLLS

last 3 to 5 times longer than ordinary covered rolls

SPEC Pinch Rolls, Billy Rolls, Deflector Rolls, Pressure Rolls, Carrier Rolls, etc., are giving miraculous results in leading skin pass mills for continuous strip, electrolytic tin, galvanizing, silicon, stainless, etc. Operating speeds up to 4000 FPM . . . Heat resistant up to and exceeding 500° F. . . . Acid- oil- and grease-resistant . . . Coefficient of friction .35.

STRENGTH • DURABILITY • LIFE
never before achieved in covered rolls

Switch to SPEC rolls for reduced downtime—lower maintenance cost—increased production. Made with a variety of different characteristics to meet specific conditions. WRITE, WIRE or PHONE for details and applications.

Write us or contact one of these SPEC Representatives for SPECialized Roll Service

T. A. REILLY COMPANY
139 N. Clark St., Chicago 2, Illinois
Phone — Franklin 2-3474

J. E. KIEFER COMPANY
P. O. Box 3193, Youngstown 12, Ohio
Phone — Sterling 2-6386

DeSHAZO-THOMAS
107 Broadway, P. O. Box 5822, Birmingham 9, Ala.
Phones — Tremont 1-4127; Tremont 9-6610

EMPIRE ENG. CO.
385 East Green Street, Pasadena 1, California
Phone — Ryan 1-6178

A. M. McINTYRE
8226 Buchanan Street, St. Louis 14, Missouri
Phone — Harrison 83940

HIGGINSON ENGINEERING CO.
275 James St. North, P. O. Box 23,
Hamilton, Ontario, Canada

STEEL PLANT EQUIPMENT CORP.
Room 50, Curren Arcade Bldg., Norristown, Pa.
Phone — Norristown, Pa. 5-7539

EUROPEAN REPRESENTATIVE
DR.-ENG. GEORG WEDDIGE
Kirchstrase 124
Dinslaken (Niederrhein) Fernruf 3101
GERMANY

*Steel Plant Equipment Corporation

SPECIALISTS IN COVERED ROLLS

3117 Grant Building

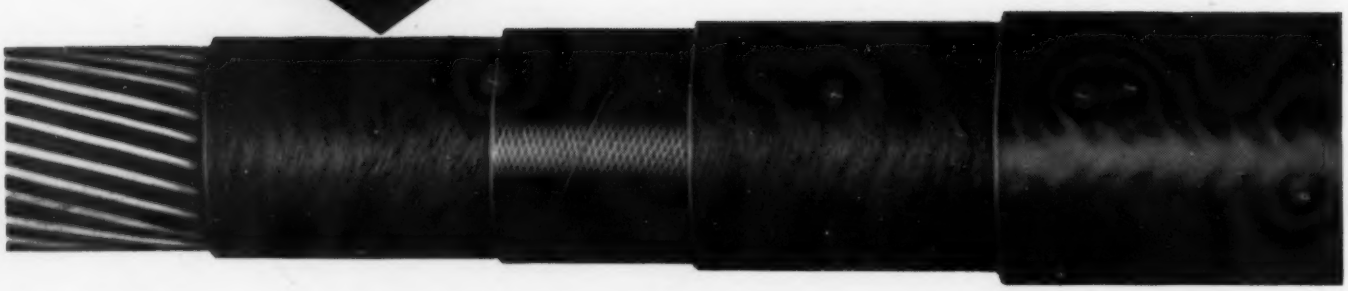
EXpress 1-3277

Pittsburgh 19, Pa.

ANNEALING • PICKLING • SCRUBBING • FINISHING • ELECTRO-TINNING

Look beneath the braid

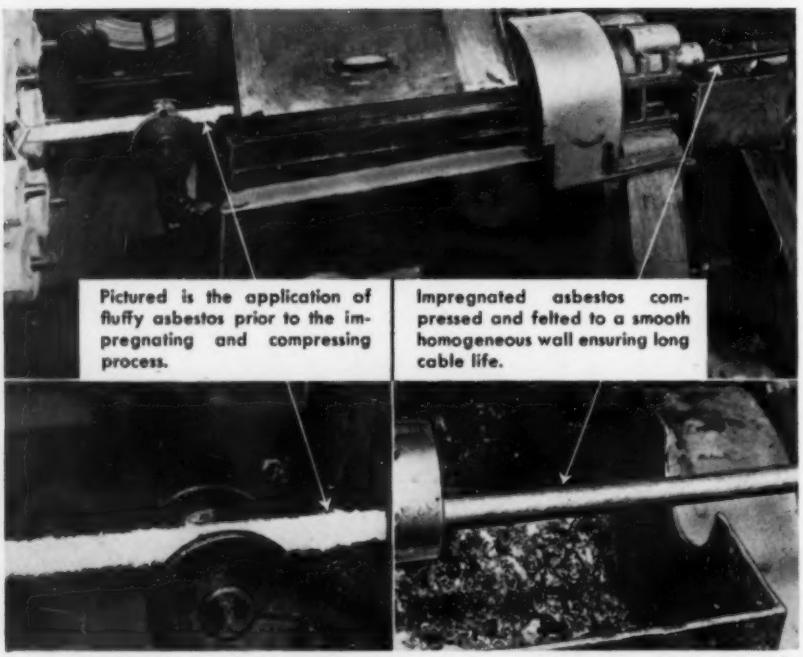
...that's where quality begins



these service proved felted asbestos walls insure uninterrupted operation with

ROCKBESTOS A. V. C.®

(N.E.C. Type AVA)



Pictured is the application of fluffy asbestos prior to the impregnating and compressing process.

Impregnated asbestos compressed and felted to a smooth homogeneous wall ensuring long cable life.

There's a reason why Rockbestos A.V.C. (N.E.C. Type AVA) gives such outstanding service in industry. It is the uniform, dense, felted asbestos walls which have been thoroughly impregnated with selected compounds and firmly compressed without laps, seams or joints to make them resistant to heat and moisture. Felted asbestos walls seal the varnished cambric tapes away from heat and moisture . . . keep dielectric strength high . . . add strength and protection against damage from flexing.

Because of felted asbestos wall construction you benefit with trouble-free, uninterrupted service under conditions such as high ambient temperature, overloads, exposure to heat, oil, grease, corrosive fumes and exposure to moisture.

Complete construction and test specifications of Rockbestos A.V.C. (N.E.C. Type AVA) are in the new booklet: "Specification RSS-88."

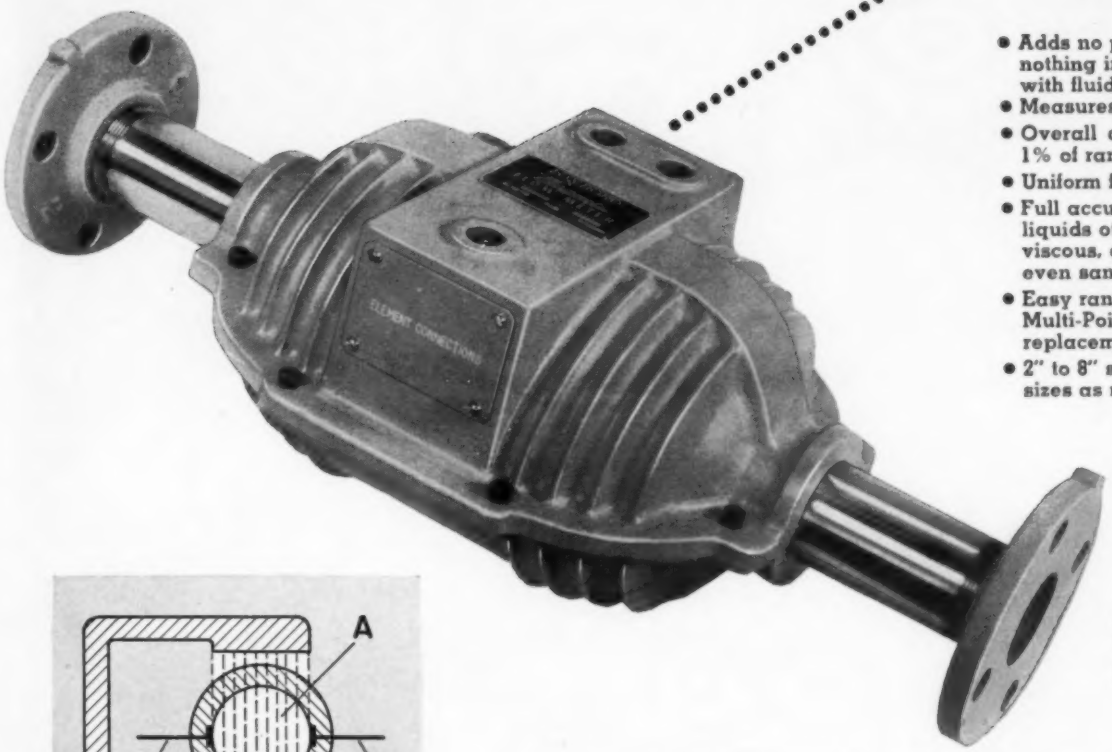
Write for your free copy.

ROCKBESTOS
PRODUCTS CORP.
NEW HAVEN 4, CONN.

NEW YORK • CLEVELAND • DETROIT • CHICAGO
PITTSBURGH • ST. LOUIS • LOS ANGELES • NEW ORLEANS
OAKLAND, CALIFORNIA

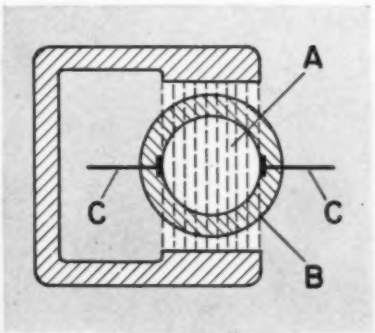
STOCKED COAST TO COAST
Standard Rockbestos A.V.C. construction (N.E.C. types AVA, AVB, etc.) are available for immediate shipment. Call or write nearest branch office.

NEW! a flow meter with no flow restrictions!



- Adds no pressure drop — nothing inside pipe to interfere with fluid flow.
- Measures fluid velocity directly.
- Overall accuracy better than 1% of range over entire scale.
- Uniform flow scale.
- Full accuracy sustained even on liquids other meters can't handle: viscous, corrosive, or pulpy — even sand-water slurries.
- Easy range change — either by Multi-Point Switch or range coil replacement, as preferred.
- 2" to 8" sizes standard — larger sizes as required.

FOXBORO MAGNETIC FLOW METER



SIMPLE, TROUBLEFREE, OPERATION

The Foxboro Magnetic Flow Meter operates on the same principle as a power generator. A magnetic field (A) is maintained through a standard pipe section (B) of stainless steel or other non-magnetic material. This pipe section is lined with Kel-F® or other insulating material. Liquid passing through pipe acts as moving conductor, generating an electric voltage which varies in proportion to liquid's average velocity. Flush electrodes (C) in pipe wall "pick up" this voltage which is recorded in desired flow units by Dynalog Electronic Recorder or Controller.

This premium-performance meter measures *magnetically* the flow rate of virtually any liquid except hydrocarbons. It completely ignores such common metering headaches as turbulence, suspended solids, and variations in conductivity, density, and viscosity. It even measures reversing flows.

Installation is simple. The magnetic spool piece connects into the line like any equivalent length of pipe — no seals, purges, meter runs, or straightening vanes required. Connects by 2-conductor cable to remote Dynalog Electronic Flow Recorder.

Maintenance is practically eliminated. There are no pressure taps to become plugged or frozen, no working parts to foul.

Foxboro Magnetic Flow Meters are already in use on such widely different liquids as beer, sand-and-water, rosin size, rock-and-acid slurry, viscose, and highly corrosive liquid detergent. Find out how this precise, troublefree flow meter can help *your* processing. Write for complete details.

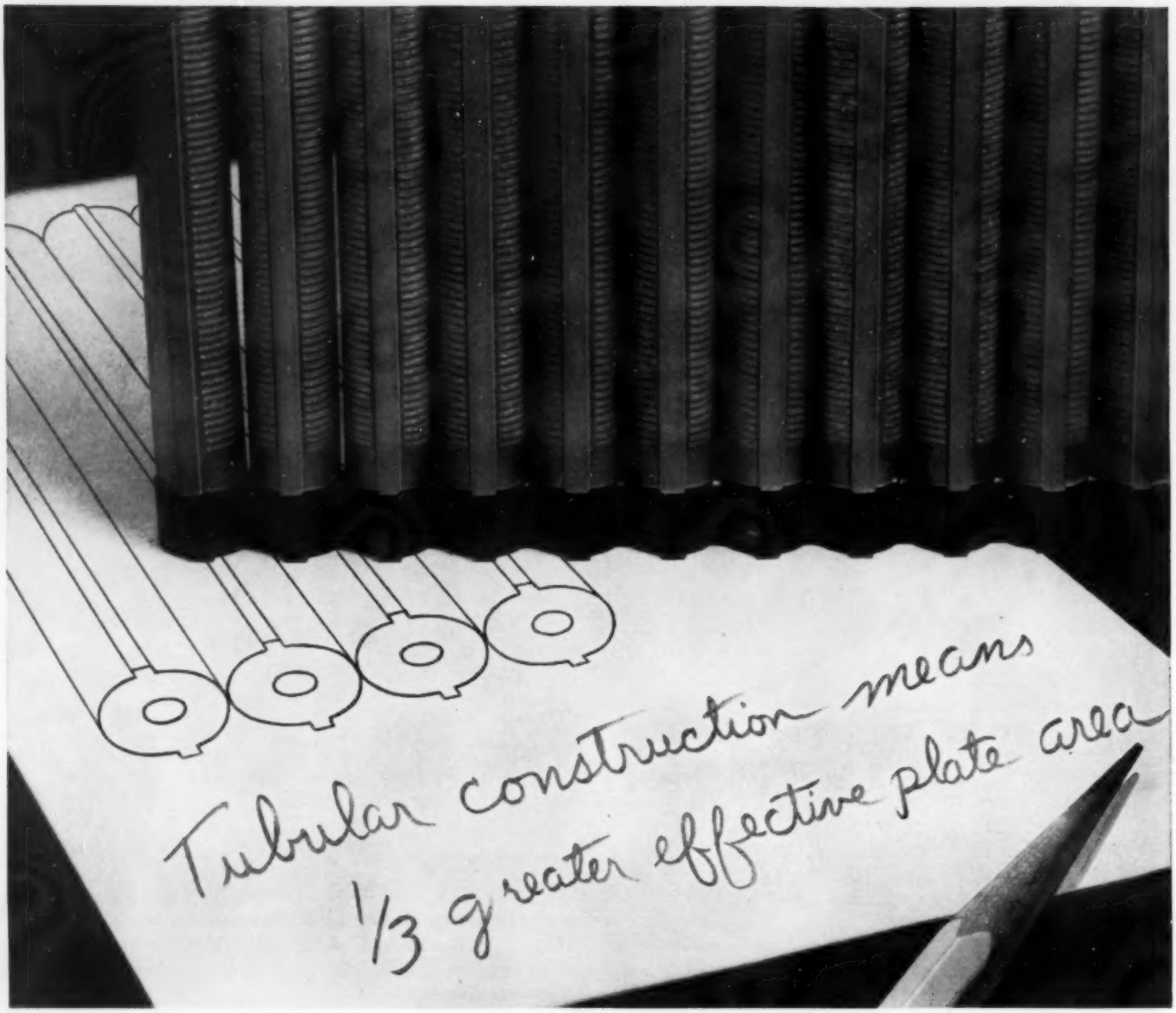
THE FOXBORO COMPANY, 582 NEPONSET AVENUE, FOXBORO, MASS., U. S. A.

FOXBORO
REG. U. S. PAT. OFF.

Foremost in FLOW METERING

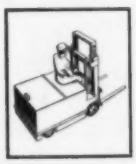
FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

EXIDE-IRONCLAD BATTERIES



Greater effective plate area boosts power for peak loads

BATTERY FOR POWERED HAND TRUCK, Model TH. Fits snugly into space provided on truck. Has tubular construction of positive plates, Silvium grids, "Permanized" negative plates, extra heavy connectors and all other Exide-Ironclad advantages that mean power to spare in heavy duty applications. Write for Bulletin 5161.



According to general principles of storage battery engineering, power reserve is governed by positive plate area. In the Exide-Ironclad greater effective plate area is achieved without increasing plate size. Here's how:

In the Exide-Ironclad positive plate, active material is held captive in tubes of slotted polyethylene. These tubes are arranged in a tight row with electrical connections only at the top. The actual surface of the plate is the combined semicircular sides of these tubes—the total surface area being roughly one-third more than the projected dimensions of the plate.

In use, this unique design feature means that more active material is exposed to electrolyte for a given size battery. It means the battery can provide power to spare for peak loads as well as a dependable source of continuous power.

Only Exide-Ironclad Batteries have this advantage. Be sure to specify them when you order—for either new equipment or for replacement. Exide Industrial Division, The Electric Storage Battery Company, Phila. 2, Pa.

Exide®

This C-51 deseaming blowpipe opens transverse plate welds in steel barge bottoms 7 times faster than the previously used process.

Barges get new lease on life...

FOR 70% LESS COST

Deseaming blowpipes have cut the time required to remove these steel barge bottoms from 4 days per barge, to only 1½—and cut costs $500 per barge....

In this operation, the barges were rolled over in the water. Bottom plates were deseamed and removed, and then new plates UNIONMELT welded in position. Before removing the old plates, it was necessary to "open" seam welds, plug welds, and rivets. The deseaming blowpipes did this work with maximum speed and economy—and with minimum nicking into the support members beneath the plates.

Deseaming blowpipes operate with a low-velocity oxygen stream, and make a wide pass in metal at high speeds. The depth of penetration is controlled by regulating oxygen pressure. Lightweight, easy to handle deseaming blowpipes are speeding production and repair operations throughout industry.

For more information on this or any other of LINDE's modern, money saving processes, call your local LINDE representative. Start saving now, call him today.

Linde Air Products Company
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: LINDE AIR PRODUCTS COMPANY
Division of Union Carbide Canada Limited, Toronto
(formerly Dominion Oxygen Company)

Linde
Trade-Mark

The terms "Linde" and "Unionmelt" are registered trade-marks of Union Carbide and Carbon Corporation.

NEW

Model Aire-Rectifier by LINTERN

offers many improvements

Eliminated entirely are the copper refrigerant lines. This means also the elimination of soldered joints — about 30 on the average installation. We have replaced these copper lines with high pressure hydraulic hose especially designed for **Freon** refrigerants. Hose connections are high quality **Hoze-Lok** fittings.

Advantages are many, such as (1) elimination of vibration problems, (2) avoidance of leaks, (3) reduced installation time and (4) quick disconnection of any part for service.

NEW

Combination Cooling Unit

New Cab Unit by Lintern Corporation includes cooling, electric heating and complete air filtering.

Another noteworthy development is the new Cooling (Cab) Unit which can be located on ceiling or placed on floor, depending on headroom requirements.

Since this new unit is for pulpits as well as crane cabs, it offers users the advantages of standardization with consequent reduction in service parts.

The filters can be changed by simply slipping them out — without removing the service panel. The mechanical filter — **Pliotron** — is easily cleaned. The activated carbon filter is of the permanent type which can be reactivated. All this sets a new record for ease of service and low cost maintenance.

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Write to our P-A Sales Department for Bulletin M-102 describing the simple operating principle of the P-A Venturi Scrubber, and Bulletin M-103 explaining its metallurgical fume applications in the steel industry.

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EQUIPMENT NEWS

(Continued from page 201)

ously and indicates faults instantly in any one of six monitored circuits. It requires no warm-up time, is electrically isolated from monitored circuits, and utilizes printed circuits and standard electronic components for minimum maintenance.

As long as each monitored circuit is trouble-free, its signal lamp remains lighted. But if a fault occurs, even momentarily, the lamp is extinguished and remains so until the fault finder is manually reset. This reset feature assures the detection of momentary faults and also makes the unit a fail-safe device; if the device were designed to signal a fault by flashing a light, failure of the lamp or any part of the circuit would prevent warning signals.

Its key component is a cold-cathode gas-filled tube which blocks current flow until its starting anode is energized; current flow ceases when current to its main anode is interrupted. Circuitry of the fault finder is such that current flows to the indicator lamp so long as this main anode circuit is not interrupted.

Book Reviews . . .

"Foundry Practices," by S. E. Rusinoff has very recently been published by the American Technical Society, 848 East Fifty-Eighth Street, Chicago 37, Ill. The book contains 261 pp., 5¼ x 8¼-in., is cloth bound and is priced at $6.50. This publication is a comprehensive account of modern successful foundry operation. The author of this book, an experienced engineer and teacher, has a thorough view of all the aspects of metal casting and the ability to organize, clarify and communicate complex material. The book describes modern technology's fusion of the best of the old with new methods, new machines, and new materials to result in higher quality castings produced at a lower cost. It contains appropriate photographs, technical drawings and diagrams, tables and a review of questions at the end of each chapter. It will be found useful to the student in technical school, the engineering student, foreman, plant supervisors and any person interested in the subject.

But why MEN over 45?

Our doctors still don't know *why*, but if you are a man over 45 you are six times as likely to develop lung cancer as a man of your age twenty years ago. They *do* know, however, that their chances of saving your life could be about *ten times* greater if they could only detect cancer long before you yourself notice any symptom. (Only 1 in every 20 lung cancers is being cured today, largely because most cases progress too far before detected.)

That's why we urge that you make a habit of having your chest X-rayed every six months, no matter how well you may *feel*. The alarming increase of lung cancer in men over 45 more than justifies such precautions. Far too many men die *needlessly!*

Our new film "The Warning Shadow" will tell you what every man should know about lung cancer. To find where and when you can see this film, and to get life-saving facts about other forms of cancer, phone the American Cancer Society office nearest you or simply write to "Cancer"—in care of your local Post Office.

American Cancer Society

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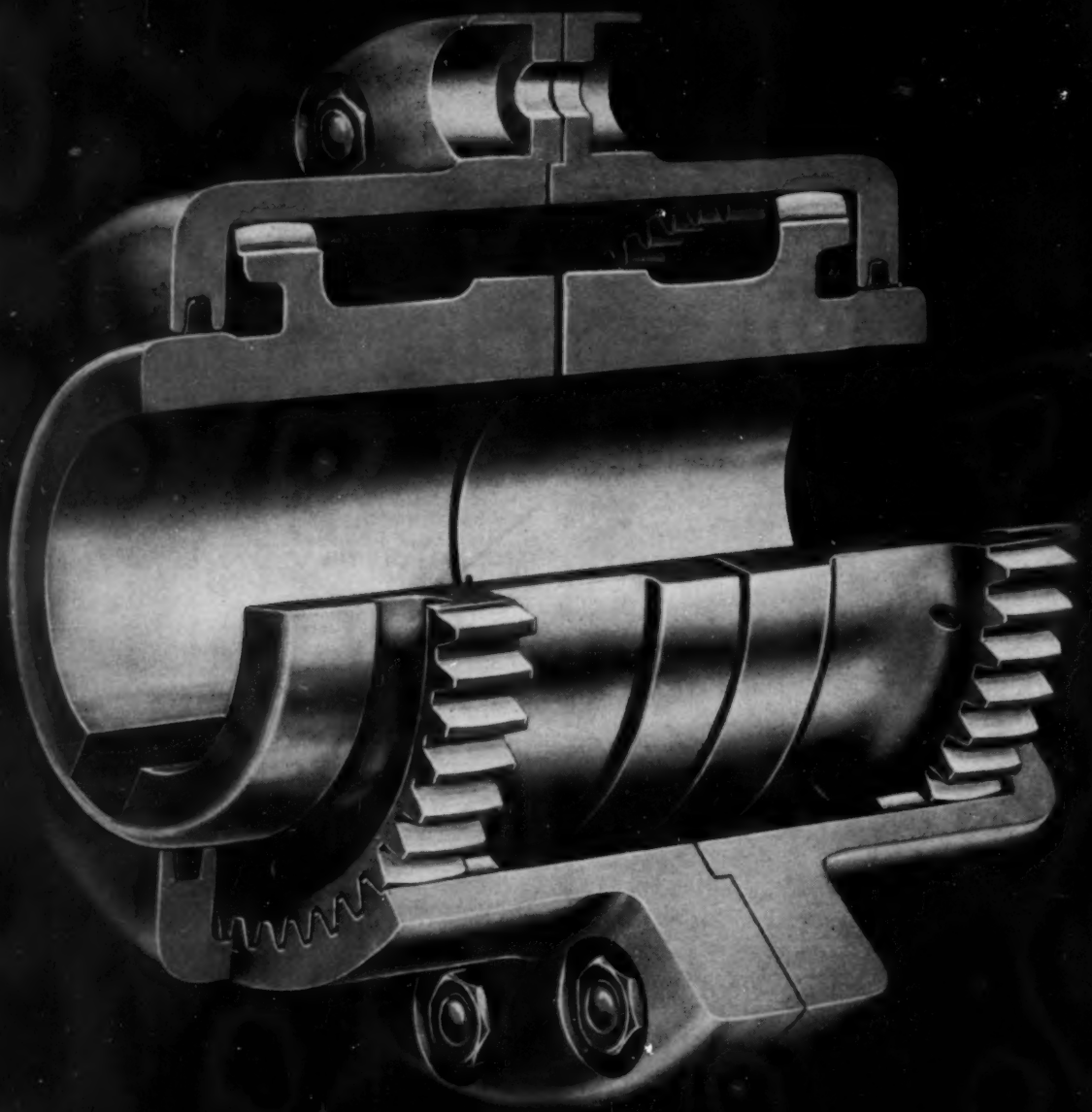

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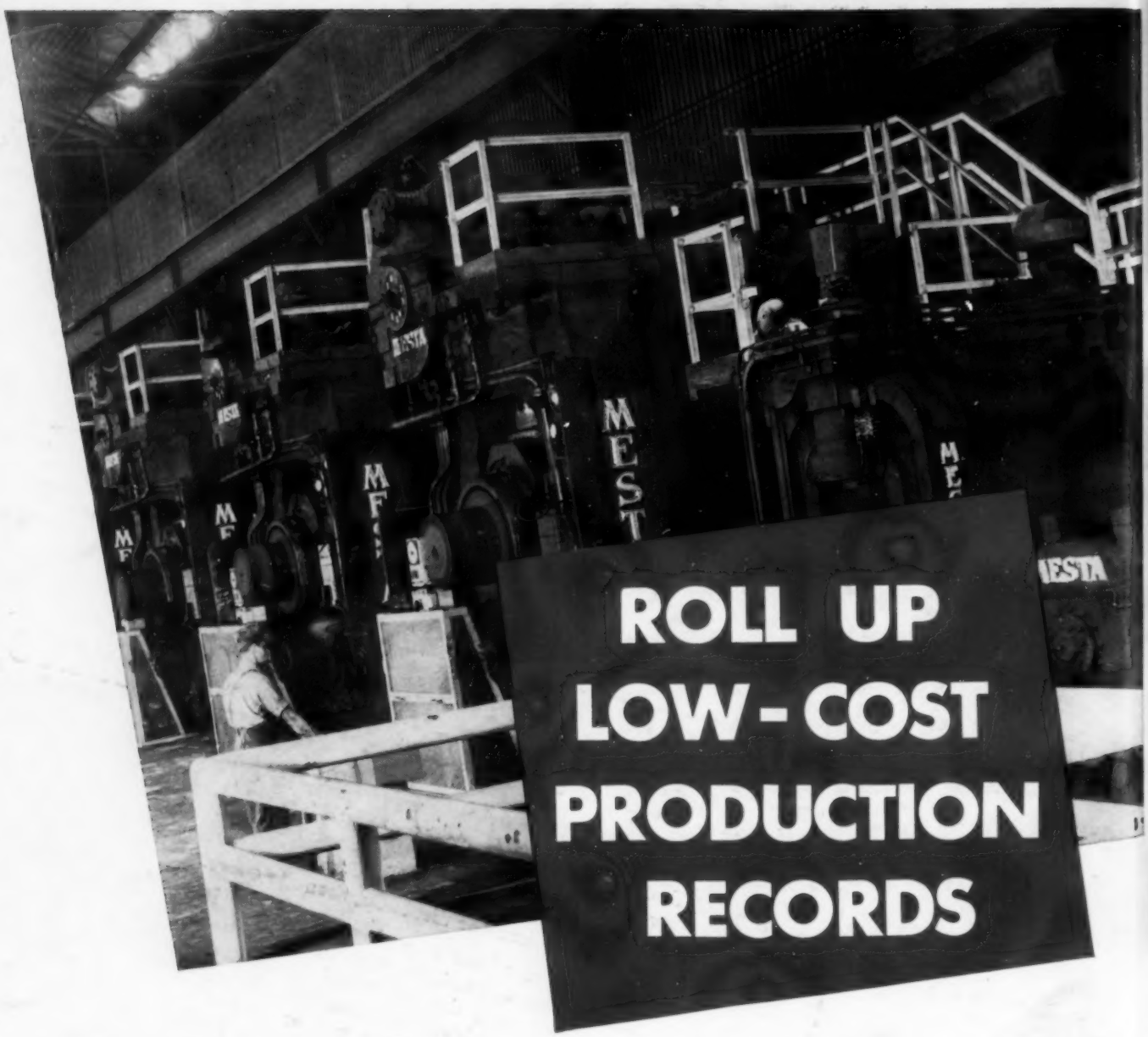

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